PROJECT MANUAL FOR:
University of Missouri
Middlebush Farm - Nextgen Center of Excellence for Influenza Research, Phase II

PROJECT NUMBER:
CP230831

AT:
UNIVERSITY OF MISSOURI – COLUMBIA
COLUMBIA, MISSOURI

FOR:
THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:
Clark & Enersen
Architect of Record
2020 Baltimore Ave, Suite 300
Kansas City, MO 64108
816.474.8237

Clark & Enersen
Mechanical, Plumbing, & Electrical Engineer of Record
2020 Baltimore Ave, Suite 300
Kansas City, MO 64108
816.474.8237

SK Design Group, Inc.
Civil Engineer of Record
4600 College Boulevard, Suite 100
Overland Park, KS 66211913.451.1818

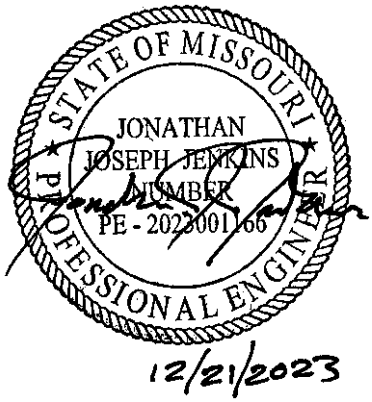
Leigh + O'Kane
Structural Engineer of Record
250 NE Mulberry Street, Suite 201
Lee's Summit, MO 64086
816.444.3144

DATE:
Contract Documents: December 21, 2023

I hereby certify that drawing sheets G0.00, G0.01, G0.10, G0.20, G0.21, A0.00, A0.10, A1.10, A1.11, A1.12, A1.15, A1.20, A1.21, A1.22, A1.30, A2.10, A3.10, A4.10, A6.10, A6.40, A7.10, A8.10, F1.11 and specification sections 017329, 024119, 055000; and sections in divisions 06, 07, 08,09,10, 11,12, 13 have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

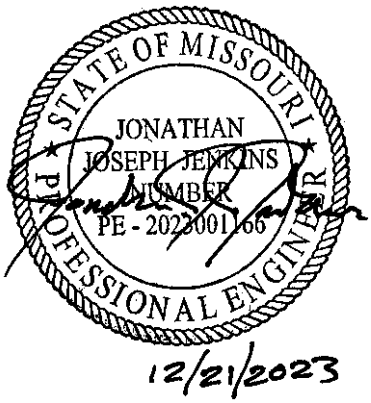
Signature: _____

I hereby certify that drawing sheets FS1.01, FS1.02, M0.00, M0.02, M1.01, M1.02, M1.03, M2.01, M3.01, M3.02, M4.01, M5.01, M5.02, M6.01, M6.02, M6.03, M6.04, M6.05, M7.01, M7.02, P0.01, P1.01, P1.02, P1.03, P1.04, P2.01, P2.02, P3.01, P3.02, P4.01, P4.02, P5.01 and specification sections in divisions 21, 22, 23 have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.



Signature: _____

I hereby certify that drawing sheets E0.00, E0.01. E0.10, E1.11, E2.11, E2.12, E3.01, E4.01, E4.02, E5.01, E5.02, E5.03, E5.04 and specification in divisions 26, 27, 28, and section 337119 have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.



Signature: _____

I hereby certify that Drawing sheets C0.51, C0.61, C1.01, C2.01, C3.01, C3.11, C4.01, C4.11, C4.12, C5.01, C5.02, & C6.01 have been prepared under my supervision and Specification sections 015713, 311000, 312000, 312319, 321313, 321373, 323113, 329119, 329219, 333100, and 334100 have all been prepared by me. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature: _____

I hereby certify that Drawing sheets S0.01, S1.10, S1.11, S2.10, S2.20, S5.10, S5.11, S5.12 and Specification sections in divisions 03, 04 and 054000 have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature: _____

TABLE OF CONTENTS

TITLE		PAGE
DIVISION 1	GENERAL REQUIREMENTS	
	Advertisement for Bids	
1.A	Bid for Lump Sum Contract	1.A 1-7
1.B	Bidder's Statement of Qualifications	BSQ/1-2
1.B.2	Supplier Diversity Compliance Evaluation	SD 1-2
1.B.3	Application for Waiver	SD 3-4
1.B.4	Affidavit for Affirmative Action	SD 5-6
1.B.5	Certifying Supplier Diversity Agencies	SD 7
1.B.6	Newspapers for Outreach to Diverse Suppliers	SD 8
1.B.7	Affidavit of Supplier Diversity Participation	SD 9
1.C	Information for Bidders	IFB/1-5
1.D	General Conditions	GC/1-39
1.E	Special Conditions	SC 1-14
1.E.1	Scheduling Specification	SS 1- 3
1.E.2	Roofing System Manufacturer's Certification	RSMC1
1.E.3	Contractor's Roofing/Flashing/Sheet Metal Guarantee	CRFSMG 1-2
1.E.4	Shop Drawing and Submittal Log	SDSL 1-9
1.E.5	Operating Instructions and Service Manual Log	OMML 1-4
1.E.6	Closeout Log	CLOSL 1-3
1.E.7	Sustainability Report	SUS1-1
1.E.8	Quality Assurance Checklist	COM 1-21
1.F	Index of Drawings	INDEX 1-2
1.G	Prevailing Wage Rates	PW 1-4
1.H	Alternates	ALT 1
	Geotechnical Engineering Report (For Information Only)	1-57
01 57 13a	Temporary Erosion and Sediment Control	1-3
01 57 13b	Temporary Erosion and Sediment Control - SWPPP	1-46
01 73 29	Cutting and Patching	1.-2
01 74 19	Construction Waste Management Tracking	1-6
01 91 13	General Commissioning Requirements	1-10
DIVISION 2	EXISTING CONDITIONS	
02 41 19	Selective Demolition	1-7
DIVISION 3	CONCRETE	
03 10 00	Concrete Forming and Accessories	1-5
03 20 00	Concrete Reinforcing	1-5
03 30 00	Cast-in-Place Concrete	1-23
DIVISION 4	MASONRY	
04 20 00	Unit Masonry	1-15

DIVISION 5	METALS	
05 40 00	Cold-Formed Metal Framing	1-10
05 50 00	Metal Fabrications	1-6
DIVISION 6	WOOD AND PLASTICS	
06 10 53	Rough Carpentry	1-2
DIVISION 7	THERMAL AND MOISTURE PROTECTION	
07 21 00	Thermal Insulation	1-3
07 62 00	Sheet Metal Flashing and Trim	1-5
07 72 53	Snow Guards	1-2
07 92 00	Joint Sealants	1-8
07 95 00	Expansion Control	1-4
DIVISION 8	OPENINGS	
08 11 13	Hollow Metal Doors and Frames	1-9
08 16 13	Fiberglass Reinforced Polymer Doors	1-4
08 31 13	Access Doors and Frames	1-4
08 41 13	Aluminum-Framed Entrances and Storefronts	1-7
08 71 11	Door Hardware	1-15
08 80 00	Glazing	1-4
DIVISION 9	FINISHES	
09 22 16	Non-Structural Metal Framing	1-3
09 29 00	Gypsum Board	1-7
09 30 00	Tiling	1-5
09 67 33	Trowel-Applied Resinous Flooring and Walls	1-9
09 68 13	Tile Carpeting	1-4
09 91 13	Exterior Painting	1-5
09 91 23	Interior Painting	1-6
09 96 00	High-Performance Coatings	1-9
DIVISION 10	SPECIALTIES	
10 26 00	Wall Protection	1-3
10 28 00	Toilet Accessories	1-7
10 44 00	Fire Protection Cabinets	1-3
DIVISION 11	EQUIPMENT	
11 53 19	Dry Heat Sterilizer	1-8
11 53 20	Steam Heat Sterilizer	1-7
11 53 53	Biological Safety Cabinets	1-7
DIVISION 12	FURNISHINGS	
12 35 53.15	Stainless Steel Laboratory Casework	1-8
DIVISION 13	SPECIAL CONSTRUCTION	
13 34 19	Metal Building Systems	1-24
DIVISION 14	CONVEYING SYSTEMS (Not Used)	
DIVISION 21	FIRE PROTECTION	

21 05 00	Basic Fire Suppression Requirements	1-18
21 05 00.01	Pressure Test Log	1-1
21 05 13	Electrical Requirements for Fire Suppression Equipment	1-5
21 05 19	Fire Suppression Gauges	1-3
21 05 29	Fire Suppression Hangers and Supports	1-6
21 05 53	Fire Suppression Identification	1-3
21 13 13	Fire Suppression Systems	1-11
DIVISION 22	PLUMBING	
22 05 00	Basic Plumbing Requirements	1-18
22 05 00.01	Pipe Pressure Test Log	1-1
22 05 13	Electrical Requirements for Plumbing Equipment	1-7
22 05 19	Plumbing Meters and Gauges	1-8
22 05 29	Plumbing Hangers and Supports	1-18
22 05 33	Heat Trace for Plumbing Piping	1-13
22 05 48	Plumbing Vibration Controls	1-9
22 05 53	Plumbing Identification	1-3
22 07 16	Plumbing Equipment Insulation	1-3
22 07 19	Plumbing Piping Insulation	1-5
22 10 00	Plumbing Piping	1-10
22 11 19	Plumbing Specialties	1-6
22 13 43	Facility Packaged Sewage Pumping Stations	1-10
22 21 23	Plumbing Pumps	1-3
22 30 00	Plumbing Equipment	1-5
22 40 00	Plumbing Fixtures	1-6
22 67 00	Reverse Osmosis (RO) Water Piping	1-6
22 67 01	Water Purification System Equipment	1-4
DIVISION 23	HVAC	
23 05 00	Basic HVAC Requirements	1-17
23 05 13	Electrical Requirements for Mechanical Equipment	1-6
23 05 19	HVAC Meters and Gauges	1-6
23 05 29	HVAC Hangers and Supports	1-9
23 05 48	HVAC Vibration Controls	1-7
23 05 53	HVAC Identification	1-3
23 05 93	Testing, Adjusting, and Balancing	1-3
23 07 13	Ductwork Insulation	1-5
23 07 16	HVAC Equipment Insulation	1-4
23 07 19	HVAC Piping Insulation	1-6
23 09 00	Digital Control Equipment	1-16
23 08 00	Mechanical Commissioning Requirements	1-22
23 09 93	Sequence of Operation	1-1
23 21 13	Hydronic Piping	1-9
23 21 16	Hydronic Specialties	1-5
23 21 23	HVAC Pumps	1-8
23 31 13	Ductwork	1-16
23 33 00	Ductwork Accessories	1-9
23 34 23	HVAC Power Ventilators	1-6
23 36 00	Air Terminal Units	1-3
23 37 00	Air Outlets and Inlets	1-3
23 52 00	Heating Boilers	1-10
23 74 13	Dedicated Outdoor Air Systems	1-13
23 81 26	Split Systems	1-7

23 84 13	Humidifiers	1-9
DIVISION 26	ELECTRICAL	
26 05 00	Electrical General Provisions	1-10
26 05 01	Basic Material and Methods	1-10
26 05 19	Conductors	1-5
26 05 26	Grounding System	1-5
26 05 33	Raceways	1-7
26 05 73	Low Voltage Electrical Systems Studies	1-3
26 08 00	Electrical Commissioning Requirements	1-10
26 22 00	Dry-Type Transformers	1-4
26 24 13	Switchboards	1-9
26 24 16	Panelboards	1-6
26 25 50	Dual Purpose Docking Station	1-4
26 27 26	Wiring Devices	1-4
26 29 13	Motor Controllers	1-5
26 29 23	Variable-Frequency Drives	1-7
26 32 13	Electrical Emergency Standby Power System Generator Set	1-15
26 36 23	Automatic Transfer Switch	1-11
26 41 00	Lightning Protection System	1-7
26 51 00	Lighting	1-5
DIVISION 27	TELECOMMUNICATIONS	
27 00 00	Telecommunications	1-3
DIVISION 28	ELECTRONIC SAFETY AND SECURITY	
28 31 11	Addressable Fire Alarm System	1-12
28 55 00	RF Survey for In-Building Two-Way Emergency Responder System	1-3
DIVISION 29-30	(NOT USED)	
DIVISION 31	EARTH WORK	
31 10 00	Site Clearing	1-3
31 20 00	Earth Moving	1-20
31 23 19	Dewatering	1-2
DIVISION 32	EXTERIOR IMPROVEMENTS	
32 13 13	Concrete Paving	1-6
32 13 73	Concrete Paving Joint Sealant	1-3
32 31 13	Chain Link Fences and Gates	1-3
32 91 19	Landscape Grading	1-2
32 92 19	Seeding	1-3
DIVISION 33	UTILITIES	
33 31 00	Sanitary Utility Sewerage Piping	1-5
33 41 00	Storm Utility Drainage Piping	1-5
33 71 19	Underground Duct Banks	1-5

END OF SECTION

PLANNING DESIGN & CONSTRUCTION

900 E. Stadium, Ste. 130
Columbia, Missouri 65211
Telephone: (573) 882-6800

ADVERTISEMENT FOR BIDS

Sealed bids for:

MIDDLEBUSH FARM –
NEXTGEN CENTER FOR INFLUENZA RESEARCH - PHASE II
UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI
PROJECT NUMBER: CP230831 CONSTRUCTION ESTIMATE: $4,987,450 - $5,541,612

will be received by the Curators of the University of Missouri, Owner, at Planning, Design & Construction, Room L100 (Front Reception Desk), General Services Building, University of Missouri, Columbia, Missouri 65211, until 1:30 p.m., C.T., February 1, 2024 and then immediately opened and publicly read aloud.

Drawings, specifications, and other related contract information may be obtained at http://operations-webapps.missouri.edu/pdc/adsite/ad.html. Electronic bid sets are available at no cost and may be printed as desired by the plan holders. No paper copies will be issued. If paper copies are desired, it is the responsibility of the user to print the files or have them printed.

Questions regarding the scope of work should be directed to Hadley Stolte with Clark & Enersen at (816) 474-8237 or hadley.stolte@clarkenersen.com. Questions regarding commercial conditions should be directed to Ashley Karpel at (573) 882-1349 or karpela@missouri.edu.

A prebid meeting will be held at 10:00 a.m., C.T., January 18, 2024 in the General Services Bldg., Room 194A, followed by a site walk-through.

A Diversity Participation goal of 10% MBE, 10% Combined WBE, DBE, Veteran Owned Business and 3% SDVE has been established for this contract.

The Owner reserves the right to waive informalities in bids and to reject any and all bids.

Individuals with special needs as addressed by the Americans with Disabilities Act may contact (573) 882-6800.

Advertisement Date: January 4, 2024

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 1.A

BID FOR LUMP SUM CONTRACT

Date:_____

BID OF _____
(hereinafter called "Bidder") a corporation* organized and existing under laws of the State of _____
_____,
a partnership* consisting of _____,
an individual* trading as _____,
a joint venture* consisting of _____
_____.
*Insert Corporation(s), partnership or individual, as applicable.

TO: Curators of the University of Missouri
Campus Facilities. Planning, Design and Construction
General Services Building
Room L100
University of Missouri
Columbia, Missouri 65211

1. Bidder, in compliance with invitation for bids for construction work in accordance with Drawings and Specifications prepared by CLARK & ENERSEN, entitled " Middlebush Farm – NextGen Center for Influenza Research, Phase II ", project number CP230831, dated December 21, 2023 having examined Contract Documents and site of proposed work, and being familiar with all conditions pertaining to construction of proposed project, including availability of materials and labor, hereby proposes to furnish all labor, materials and supplies to construct project in accordance with Contract Documents, within time set forth herein at prices stated below. Prices shall cover all expenses, including taxes not covered by the University of Missouri's tax exemption status, incurred in performing work required under Contract documents, of which this Bid is a part.

Bidder acknowledges receipt of following addenda:

Addendum No. _____Dated _____
Addendum No. _____Dated _____
Addendum No. _____Dated _____
Addendum No. _____Dated _____

2. In following Bid(s), amount(s) shall be written in both words and figures. In case of discrepancy between words and figures, words shall govern.

3. BID PRICING
a. Base Bid:

The Bidder agrees to furnish all labor, materials, tools, and equipment required for the new Nextgen Center of Excellence for Inf, all site and utility work, all as indicated on the Drawings and described in these Specifications for sum of:

_____
_____DOLLARS ($_____).

b. Additive Alternate Bids:

Above Base Bid may be changed in accordance with following Alternate Bids as Owner may

elect. Alternates are as described in Section 1.H of Project Manual. Alternates are written in a priority order, but Owner is not required to accept or reject in order listed. This is a one (1) contract project, therefore, Alternates shall be studied by each Bidder to determine effect on Bids of Contractor and each Subcontractor and/or Material supplier.

(1) Additive Alternate No. 1: **Dry Head Sterilizer**

Base Bid: Provide supporting utilities rough-in for future installation of sterilizer unit in Room 217A Dirty Corridor; provide floor, wall and ceiling finishes in area.

Add Alternate: Add new Electric Heat Sterilizer with utility connections. Delete resinous flooring and add concrete sealer; delete resinous cove base.

_____
_____DOLLARS ($_____).

(2) Additive Alternate No. 2: **Steam Head Sterilizer**

Base Bid: Provide utility rough-in for future installation of autoclave unit in Room Mechanical 210; provide wall infill with separate studs and drywall framing including drywall joint to allow for future installation of unit.

Add Alternate: Add new Steam Heat Sterilizer with supporting utility connections and adjacent drywall/metal stud enclosure at each side of unit wall penetration.

_____
_____DOLLARS ($_____).

(3) Additive Alternate No. 3: **Stainless Steel Mobile Casework at Procedure Rooms**

Base Bid: Provide no casework in procedure rooms.

Add Alternate: Provide mobile casework/table units at Procedure Rooms.

_____
_____DOLLARS ($_____).

(4) Additive Alternate No. 4: **Reverse osmosis water service pipe to procedure rooms for held animal feeding.**

Base Bid: Provide domestic water service pipe including source connections and terminations.

Add Alternate: Provide reverse osmosis water service pipe including source connection from purification equipment and terminations.

_____
_____DOLLARS ($_____).

c. Unit Prices:

(1) For changing specified quantities of work from those indicated by Contract Drawings and Specifications, upon written instructions of Owner, the following Unit Prices shall prevail in accordance with General Conditions.

(2) The following Unit Prices include all labor, overhead and profit, materials, equipment, appliances, bailing, shoring, shoring removal, etc., to cover all work.

(3) The following Unit Prices are required where applicable to particular Base Bid and/or Alternate being submitted.

(4) Only a single Unit Price shall be given and it shall apply for either MORE or LESS work than that indicated on Drawings and called for in Specifications as indicated to be included in Base Bid and/or Alternates. In the event that more or less units than so indicated is actually furnished, Change Orders will be issued for increased or decreased amounts as approved by the Owner.

(5) Bidder understands that the Owner will not be liable for any Unit Price or any amount in excess of Base Bid and any Alternate(s) accepted at time of award of Contract, except as expressed in written Change Orders duly executed and delivered by Owner's Representative.

(6) Unsuitable material below exposed subgrade

a. Description: Unit price for volume of unsuitable soil materials removed below Exposed subgrade as directed by the testing and inspection agency. This unit price shall include the replacement of an equal volume of satisfactory soil material.

b. Exposed Subgrade: Surface or elevation remaining after completion of excavation to required elevations indicated on drawings and specifications is unclassified and shall be included in the base bid.
Base Bid Quantity = 830 CY
1. ADD / DEDUCT $_____/Cubic Yard

(7) Building Footings

a. Description: Add or Deduct volume of building footings as needed for design loads provided by PEMB supplier.

1. Exterior Trench Footings

ADD / DEDUCT $_____/Cubic Yard Base Qty. 40 CY

2. Isolated Column Footings

ADD / DEDUCT $_____/Cubic Yard Base Qty. 94 CY

d. Allowance:

(1) None

4. PROJECT COMPLETION

a. Contract Period - Contract period begins on the day the Contractor receives unsigned Contract, Performance Bond, Payment Bond, and "Instructions for Execution of Contract, Bonds, and Insurance Certificates." Bidder agrees to complete project within five hundred sixty (560) calendar days from receipt of aforementioned documents. Fifteen (15) calendar days have been allocated in construction schedule for receiving aforementioned documents from Bidder.

b. Commencement - Contractor agrees to commence work on this project after the "Notice to Proceed" is issued by the Owner. "Notice to Proceed" will be issued within seven (7) calendar days after Owner receives properly prepared and executed Contract documents listed in paragraph 4.a. above.

c. Refer to Scheduling Requirements in Special Conditions for specific scheduling of the following activities:

1. Site Work
2. Special Work
3. Utility Shut-downs, Outages and Tie-ins
4. Refuse / Trash Removal and Materials Delivery

5. SUBCONTRACTOR LIST:

Bidder hereby certifies that the following subcontractors will be used in performance of Work:

NOTE: Failure to list subcontractors for each category of work identified on this form or listing more than one subcontractor for any category of work without designating the portion of work performed by each shall be grounds for rejection of bid. List name, city, and state of designated subcontractor, for each category of work listed in Bid For Lump Sum Contract. If work within a category will be performed by more than one subcontractor, Bidder shall provide name, city, and state of each subcontractor and specify exact portion of work to be performed by each. If acceptance/non-acceptance of Alternates will affect designation of a subcontractor, Bidder shall provide information, for each affected category, with this bid form. If Bidder intends to perform any designated subcontract work by using Bidder's own employees, then Bidder shall list their own name, city, and state. The bidder may petition the Owner to change a listed subcontractor only within 48 hours of the bid opening. See Information For Bidders Section 16 List of Subcontractors for requirements.

Work to be performed	Subcontractor Name,	City, State
Mechanical Contractor		
Electrical Contractor		

6. SUPPLIER DIVERSITY PARTICIPATION GOALS

a. The Contractor shall have as a goal, subcontracting with Minority Business Enterprise (MBE) of ten percent (10%), with Service Disabled Veteran Owned Business (SDVE) of three percent (3%); and with Women Business Enterprise (WBE), Disadvantage Business Enterprise (DBE), and/or Veteran Owned Business of ten percent (10%) of awarded contract price for work to be performed.

b. Requests for waiver of this goal shall be submitted on the attached Application For Waiver form. A determination by the Director of Facilities Planning & Development, UM, that a good faith effort has not been made by Contractor to achieve above stated goal may result

in rejection of bid.

c. The Undersigned proposes to perform work with following Supplier Diversity participation level:

MBE PERCENTAGE PARTICIPATION: _____ percent (___%)
SDVE PERCENTAGE PARTICIPATION: _____ percent (____%)
WBE, DBE, and/or VETERAN PERCENTAGE PARTICIPATION:_____ percent (____%)

d. A Supplier Diversity Compliance Evaluation form shall be submitted with this bid for each diverse subcontractor to be used on this project.

. 7. BIDDER'S ACKNOWLEDGMENTS

a. Bidder declares that he has had an opportunity to examine the site of the work and he has examined Contract Documents therefore; that he has carefully prepared his bid upon the basis thereof; that he has carefully examined and checked bid, materials, equipment and labor required thereunder, cost thereof, and his figures therefore. Bidder hereby states that amount, or amounts, set forth in bid is, or are, correct and that no mistake or error has occurred in bid or in Bidder's computations upon which this bid is based. Bidder agrees that he will make no claim for reformation, modifications, revisions or correction of bid after scheduled closing time for receipt of bids.

b. Bidder agrees that bid shall not be withdrawn for a period of sixty (60) days after scheduled closing time for receipt of bids.

c. Bidder understands that Owner reserves right to reject any or all bids and to waive any informalities in bidding.

d. Accompanying the bid is a bid bond, or a certified check or a cashier's check payable without condition to "The Curators of the University of Missouri" which is an amount at least equal to five percent (5%) of amount of largest possible total bid herein submitted, including consideration of Alternates.

e. Accompanying the bid is a Bidder's Statement of Qualifications. Failure of Bidder to submit the Bidder's Statement of Qualifications with the bid may cause the bid to be rejected. Owner does not maintain Bidder's Statements of Qualifications on file.

f. It is understood and agreed that bid security of two (2) lowest and responsive Bidders will be retained until Contract has been executed and an acceptable Performance Bond and Payment Bond has been furnished. It is understood and agreed that if the bid is accepted and the undersigned fails to execute the Contract and furnish acceptable Performance/Payment Bond as required by Contract Documents, accompanying bid security will be realized upon or retained by Owner. Otherwise, the bid security will be returned to the undersigned.

8. BIDDER'S CERTIFICATE

Bidder hereby certifies:
a. His bid is genuine and is not made in interest of or on behalf of any undisclosed person, firm or corporation, and is not submitted in conformity with any agreement or rules of any group, association or corporation.

b. He has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid.

c. He has not solicited or induced any person, firm or corporation to refrain from bidding.

d. He has not sought by collusion or otherwise to obtain for himself any advantage over any other Bidder or over Owner.

e. He will not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin in connection with performance of work.

f. By virtue of policy of the Board of Curators, and by virtue of statutory authority, a preference will be given to materials, products, supplies, provisions and all other articles produced, manufactured, mined or grown within the State of Missouri. By virtue of policy of the Board of Curators, preference will also be given to all Missouri firms, corporations, or individuals, all as more fully set forth in "Information For Bidders."

9. BIDDER'S SIGNATURE

Note: All signatures shall be original; not copies, photocopies, stamped, etc.

Authorized Signature	Date
Printed Name	Title
Company Name i.	
Mailing Address i.	
City, State, Zip i.	
Phone No.	Federal Employer ID No.
Fax No.	E-Mail Address
Circle one: Individual Partnership Corporation Joint Venture	
If a corporation, incorporated under the laws of the State of_____	
Licensed to do business in the State of Missouri? ____yes _____no	

(Each Bidder shall complete bid form by manually signing on the proper signature line above and supplying required information called for in connection with the signature. Information is necessary for proper preparation of the Contract, Performance Bond and Payment Bond. Each Bidder shall supply information called for in accompanying "Bidder's Statement of Qualifications.")

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

UNIVERSITY OF MISSOURI
BIDDER'S STATEMENT OF QUALIFICATIONS

Submit with Bid for Lump Sum Contract in separate envelope appropriately labeled. Attach additional sheet if necessary.

1. Company Name_____

   Phone# _____ Fax #:_____

   Address _____

2. Number of years in business _____. If not under present firm name, list previous firm names and types of organization.

3. List contracts on hand (complete the following schedule, include telephone number).

Project & Address	Owner/Owner's Representative	Phone Number	Architect	Amount of your Contract	Percent Completed

4. General character of work performed by your company personnel.

5. List important projects completed in the last five (5) years on a type similar to the work now bid for, including approximate cost and telephone number.

Project & Address	Owner/Owner's Representative	Phone Number	Architect	Amount of your Contract	Percent Completed

6. Other experience qualifying you for the work now bid.

7. No default has been made in any contract complete or incomplete except as noted below:
   (a) Number of contracts on which default was made _____
   (b) Description of defaulted contracts and reason therefor

8. (a) Have you or your company participated in any contract subject to an equal opportunity clause similar to that described in the General Conditions?
   Yes _____ No ____

   (b) Have you filed all required compliance reports?
   Yes _____ No ____

(c) Is fifty percent or more of your company owned by a minority?
Yes _____ No ____

(d) Is fifty percent or more of your company owned by a woman?
Yes _____ No ____

(e) Is fifty percent or more of your company owned by a service disabled veteran?
Yes _____ No ____

(f) Is fifty percent or more of your company owned by a veteran?
Yes _____ No ____

(g) Is your company a Disadvantaged Business Enterprise?
Yes _____ No ____

9. Have you or your company been suspended or debarred from working at any University of Missouri campus?
Yes _____ No ____ (If the answer is "yes", give details.)

_____

_____

10. Have any administrative or legal proceedings been started against you or your company alleging violation of any wage and hour regulations or laws?
Yes _____ No ____ (If the answer is "yes", give details.)

_____

_____

11. Workers Compensation Experience Modification Rates (last 3 yrs): ____/____/____

Incidence Rates (last 3 years): _____/____/_____

12. List banking references.

_____

_____

13. (a) Do you have a current confidential financial statement on file with Owner?
Yes _____ No ____ (If not, and if desired, Bidder may submit such statement with bid, in a separate sealed and labeled envelope.)

(b) If not, upon request will you file a detailed confidential financial statement within three (3) days?
Yes _____ No ____

Dated at _____ this _____ day of _____ 20____

_____
Name of Organization

_____
Signature

_____
Printed Name

_____
Title of Person Signing

END OF SECTION

SUPPLIER DIVERSITY COMPLIANCE EVALUATION FORM

This form shall be completed by Bidders and submitted with the Bidder's Statement of Qualifications form for each diverse firm who will function as a subcontractor on the contract.

The undersigned submits the following data with respect to this firm's assurance to meet the goal for Supplier Diversity participation.

I. Project:

_____

II. Name of General Contractor:_____

III. Name of Diverse Firm:_____

Address:_____

Phone No.:_____ Fax No.:_____

Status (check one) MBE _____ WBE _____ Veteran_____ Service Disabled Veteran_____ DBE_____

IV. Describe the subcontract work to be performed. (List Base Bid work and any Alternate work separately):

Base Bid:_____

_____

_____

_____

_____

V. Dollar amount of contract to be subcontracted to the Diverse firm:

Base Bid:_____

Alternate(s), (Identify separately):_____

_____

_____

_____

_____

VI. Is the proposed subcontractor listed in the Directory of M/W/DBE Vendors, Directory of Serviced Disabled Veterans and/or the Directory of Veterans maintained by the State of Missouri?

Yes _____ No _____

Is the proposed subcontractor certified as a diverse supplier by any of the following: federal government agencies, state agencies, State of Missouri city or county government agencies, Minority and/or WBE certifying agencies?

Yes _____ No _____ If yes, please provide details and attach a copy of the certification.

_____

_____

_____

_____

Does the proposed subcontractor have a signed document from their attorney certifying the Supplier as a Diverse and meeting the 51% owned and committed requirement?

Yes _____ No _____ If yes, please attach letter.

Signature: _____

Name: _____

Title: _____

Date: _____

APPLICATION FOR WAIVER

This form shall be completed and submitted with the Bidder's Statement of Qualifications. Firms wishing to be considered for award are required to demonstrate that a good faith effort has been made to include diverse suppliers. This form will be used to evaluate the extent to which a good faith effort has been made. The undersigned submits the following data with respect to the firm's efforts to meet the goal for Supplier Diversity Participation.

1. List pre-bid conferences your firm attended where Supplier Diversity requirements were discussed.

2. Identify advertising efforts undertaken by your firm which were intended to recruit potential diverse subcontractors for various aspects of this project. Provide names of newspapers, dates of advertisements and copies of ads that were run.

3. Note specific efforts to contact in writing those diverse suppliers capable of and likely to participate as subcontractors for this project.

4. Describe steps taken by your firm to divide work into areas in which diverse suppliers/contractors would be capable of performing.

5. What efforts were taken to negotiate with prospective diverse suppliers/contractors for specific sub-bids? Include the names, addresses, and telephone numbers of diverse suppliers/contractors contacted, a description of the information given to diverse suppliers/contractors regarding plans and specifications for the assigned work, and a statement as to why additional agreements were not made with diverse suppliers/contractors.

6. List reasons for rejecting a diverse supplier/contractor which has been contacted.

8. Describe the follow-up contacts with diverse suppliers/contractors made by your firm after the initial solicitation.

_____

_____

_____

9. Describe the efforts made by your firm to provide interested diverse suppliers/contractors with sufficiently detailed information about the plans, specifications and requirements of the contract.

_____

_____

_____

10. Describe your firm's efforts to locate diverse suppliers/contractors.

_____

_____

_____

Based on the above stated good faith efforts made to include supplier diversity, the bidder hereby requests that the original supplier diversity percentage goal be waived and that the percentage goal for this project be set at _____ percent.

The undersigned hereby certifies, having read the answers contained in the foregoing Application for Waiver, that they are true and correct to the best of his/her knowledge, information and belief.

Signature_____

Name_____

Title_____

Company_____

Date_____

AFFIDAVIT

"The undersigned swears that the foregoing statements are true and correct and include all material information necessary to identify and explain the operation of _____ _____(name of firm) as well as the ownership thereof. Further, the undersigned agrees to provide through the prime contractor or directly to the Contracting Officer current, complete and accurate information regarding actual work performed on the project, the payment therefore and any proposed changes, if any, of the project, the foregoing arrangements and to permit the audit and examination of books, records and files of the named firm. Any material misrepresentation will be grounds for terminating any contract which may be awarded and for initiating action under federal or state laws concerning false statements."

Note - If, after filing this information and before the work of this firm is completed on the contract covered by this regulation, there is any significant change in the information submitted, you must inform the Director of Facilities Planning and Development of the change either through the prime contractor or directly.

Signature _____

Name _____

Title _____

Date _____

Corporate Seal (where appropriate)

Date _____

State of _____

County of _____

On this _____ day of _____, 19_,

before me appeared (name) _____ to me personally known, who, being duly sworn, did execute the foregoing affidavit, and did state that he or she was properly authorized by (name of firm)

_____

_____to execute the affidavit and did so as his or her own free act and deed.

(Seal)

Notary Public _____

Commission expires _____

AFFIDAVIT FOR AFFIRMATIVE ACTION

State of Missouri)
) ss.
County of)

_____ first being duly sworn on his/her oath states: that he/she is the (sole proprietor, partner, or officer) of _____ _____ a (sole proprietorship, partnership, corporation), and as such (sole proprietor, partner, or officer) is duly authorized to make this affidavit on behalf of said (sole proprietorship, partnership, corporation); that under the contract known as "_____" Project No. _____ less than 50 persons in the aggregate will be employed and therefore, the applicable Affirmative Action requirements as set forth in the "Nondiscrimination in Employment Equal Opportunity," Supplemental Special Conditions, and Article 13 in the General Conditions do not apply.

_____

Subscribed and sworn before me this _____ day of _____, 19_____.

My commission expires _____, 19_____.

CERTIFYING SUPPLIER DIVERSITYAGENCIES

Diverse firms are defined in General Conditions Articles 1.1.7 and those businesses must be certified as disadvantaged by an approved agency. The Bidder is responsible for obtaining information regarding the certification status of a firm. A list of certified firms may be obtained by contacting the agencies listed below. Any firm listed as disadvantaged by any of the following agencies will be classified as a diverse firm by the Owner.

St. Louis Development Corporation
1520 Market St., Ste. 2000
St. Louis, MO 63103
P: 314.982.1400
W: www.stlouis-mo.gov/sldc/

Bi-State Development
211 N. Broadway, Ste. 700
St. Louis, MO 63102
P: 314.982.1400
W: www.metrostlouis.dbesystem.com

St. Louis Minority Business Council
211 N. Broadway, Ste. 1300
St. Louis, MO 63102
P: 314.231.5555
W: www.slmbc.org

U.S. Small Business Administration - St. Louis, MO
8(a) Contractors, Minority Small Business
1222 Spruce Street, Suite 10.103
St. Louis, MO 63101
P: 314.539.6600
W: www.sba.gov

Lambert St. Louis International Airport
Business Diversity Development Office
11495 Navaid
Bridgeton, MO 63044
P: 314-426-8111
W: www.flystl.com/business/business-diversity-development-1/directories

City of Kansas City, Missouri
Human Relations Department, MBE/WBE Division
4th Floor, City Hall
414 E. 12th Street
Kansas City, MO 64106
P: 816.513.1836
W: kcmohrd.mwdbe.com/?TN=kcmohrd

Mid-States Minority Supplier Development Council
505 N. 7th Street, Ste. 1820
St. Louis, MO 63101
P: 314.278.5616
W: midstatesdc.org

U.S. Small Business Administration - Kansas City, MO
8(a) Contractors, Minority Small Business
1000 Walnut, Suite 500
Kansas City, MO 64106
P: 816.426.4900
W: kcmohrd.mwdbe.com/?TN=kcmohrd

Missouri Department of Transportation
Division of Construction
1617 Missouri Blvd.
P.O. Box 270
Jefferson City, MO 65102
P: 573.526.2978
W: www.modot.org/mrcc-directory

Illinois Department of Transportation
MBE/WBE Certification Section
2300 Dirksen Parkway
Springfield, IL 62764
217/782-5490; 217/785-1524 (Fax)
W: webapps.dot.illinois.gov/UCP/ExternalSearch

State of Missouri OA
Office of Equal Opportunity
301 W. High St. HSC Rm 870-B
Jefferson City, MO 65101
P: 877.259.2963
W: oa.mo.gov/sites/default/files/sdvelisting.pdf
W: oeo.mo.gov/

Minority Newspapers

Dos Mundos Bilingual Newspaper
902A Southwest Blvd.
Kansas City, MO 64108
816-221-4747
www.dosmundos.com

Kansas City Hispanic News
2918 Southwest Blvd.
Kansas City, MO 64108
816/472-5246
www.kchispanicnews.com

The Kansas City Globe
615 E. 29th Street
Kansas City, MO 64109
816-531-5253
www.thekcglobe.com/about_us.php

St. Louis American
4144 Lindell
St. Louis, MO 63108
314-533-8000
www.stlamerican.com

St. Louis Chinese American News
1766 Burns Ave, Suite 201
St. Louis, MO 63132
314-432-3858
www.scannews.com

St. Louis Business Journal
815 Olive St., Suite 100
St. Louis, MO 63101
314-421-6200
www.bizjournal.com/stlouis

Kansas City Business Journal
1100 Main Street, Suite 210
Kansas City, MO 64105
816-421-5900
www.bizjournals.com/kansascity

AFFIDAVIT OF SUPPLIER DIVERSITY PARTICIPATION

The apparent low Bidder shall complete and submit this form within 48 hours of bid opening for each Diverse firm that will participate on the contract.

1. Diverse Firm:_____

   Contact Name: _____

   Address:_____

   Phone No.:_____ E-Mail:_____

   Status (check one) MBE ☐ WBE ☐ Veteran ☐ Service Disabled Veteran ☐ DBE ☐
   If MBE, Certified as (circle one): 1) Black American 2) Hispanic American 3) Native American 4) Asian American

2. Is the proposed diverse firm certified by an approved agency [see IFB article 15]? Yes ☐ No ☐

   Agency: _____[attach copy of certification authorization from agency]

   Certification Number:_____

3. Diverse firm scope work and bid/contract dollar amount of participation (List Base Bid and Alternate work separately). The final Dollar amount will be determined at substantial completion:

	Scope of Work	Bid/Contract Amount	Final Dollar Amount
Base Bid			
Alternate #1			
Alternate #2			
Alternate #3			
Alternate #4			
Alternate #5			
Alternate #6			

The undersigned certifies that the information contained herein (i.e. Scope of Work and Bid/Contract Amount) is true and correct to the best of their knowledge, information and belief.

General Contractor:_____ Diverse Firm: _____

Signature: _____ Signature: _____

Name: _____ Name: _____

Title: _____ Title: _____

Date: _____ Date: _____

The undersigned certifies that the information contained herein (i.e. Scope of Work and Final Dollar Amount) is true and correct to the best of their knowledge, information and belief. If the Final Dollar Amount is different than the Bid/Contract Amount, then attach justification for the difference.

.

Contractor: _____ Diverse Firm: _____

Signature: _____ Signature: _____

Name: _____ Name: _____

Title: _____ Title: _____

Date: _____ Date:_____

THIS PAGE INTENTIONALLY LEFT BLANK

University of Missouri

INFORMATION FOR BIDDERS

Page No.

1. Contract Documents FB/1
2. Bidder's Obligation FB/1
3. Interpretation of Documents FB/1
4. Bids FB/1
5. Modification and Withdrawal of Bids FB/2
6. Signing of Bids FB/2
7. Bid Security FB/2
8. Bidder's Statement of Qualifications FB/2
9. Award of Contract FB/2
10. Contract Execution FB/2
11. Contract Security FB/3
12. Time of Completion FB/3
13. Number of Contract Documents FB/3
14. Missouri Products and Missouri Firms FB/3
15. Supplier Diversity FB/3
16. List of Subcontractors FB/5

1. Contract Documents

1.1 Drawings, specifications, and other contract documents, pursuant to work, which is to be done, may be obtained shown in the Advertisement for Bids and Special Conditions.

2. Bidder Obligations

2.1 Before submitting bids, each bidder shall carefully examine the drawings and specifications and related contract documents, visit site of work, and fully inform themselves as to all existing conditions, facilities, restrictions, and other matters which can affect the work or the cost thereof.

2.2 Each bidder shall include in their bid the cost of all work and materials required to complete the contract in a first-class manner as hereinafter specified.

2.3 Failure or omission of any bidder to receive or examine any form, instrument, addendum, or other document, or to visit the site and acquaint themselves with existing conditions, shall in no way relieve them from any obligation with respect to their bid or contract, and no extra compensation will be allowed by reason of anything or matter concerning which bidder should have fully informed themselves prior to bidding.

2.4 Submission of bids shall be deemed acceptance of the above obligations and each and every obligation required to be performed by all of the contract documents in the event the bid is accepted.

3. Interpretation of Documents

3.1 If any prospective bidder is in doubt as to the true meaning of any part of the drawings and specifications or contract documents, they shall submit a written request to the Architect for an interpretation.

3.2 Requests for such interpretations shall be delivered to the Architect at least one (1) week prior to time for receipt of bids.

3.3 Bids shall be based only on interpretations issued in the form of addenda mailed to each person who is on the Architect's record as having received a set of the contract documents.

4. Bids

4.1 Bids shall be received separately or in combination as shown in and required by the Bid for Lump Sum contract. Bids will be completed so as to include insertion of amounts for alternate bids, unit prices and cost accounting data.

4.2 Bidders shall apportion each base bid between various phases of the work, as stipulated in the Bid for Lump Sum contract. All work shall be done as defined in the specifications and as indicated on the drawings.

4.3 Bids shall be presented in sealed envelopes which shall be plainly marked "Bids for (indicate name of project from cover sheet)" and mailed or delivered to the building and room number specified in the Advertisement for Bids. Bidders shall be responsible for actual delivery of bids during business hours, and it shall not be sufficient to show that a bid was mailed in time to be received before scheduled closing time for receipt of bids, nor shall it be sufficient to show that a bid was somewhere in a university facility.

4.4 The bidder's price shall include all federal sales, excise, and similar taxes, which may be lawfully assessed in connection with their performance of work and purchase of materials to be incorporated in the work. City & State taxes shall not be included as defined within Article 3.16 of the General Conditions for Construction Contract included in the contract documents.

4.5 Bids shall be submitted on a single bid form, furnished by the Owner or Architect. Do not remove the bid form from the specifications.

4.6 No bidder shall stipulate in their bid any conditions not contained in the bid form.

4.7 The Owner reserves the right to waive informalities in bids and to reject any or all bids.

5. Modification and Withdrawal of Bids

5.1 The bidder may withdraw their bid at any time before the scheduled closing time for receipt of bids, but no bidder may withdraw their bid after the scheduled closing time for receipt of bids.

5.2 Only telegrams, letters and other written requests for modifications or correction of previously submitted bids, contained in a sealed envelope which is plainly marked "Modification of Bid on (name of project on cover sheet)," which are addressed in the same manner as bids, and are received by Owner before the scheduled closing time for receipt of bids will be accepted and bids corrected in accordance with such written requests.

6. Signing of Bids

6.1 Bids which are signed for a partnership shall be **manually** signed in the firm name by at least one partner, or in the firm name by Attorney-in-Fact. If signed by Attorney-in-Fact there should be attached to the bid, a Power of Attorney evidencing authority to sign the bid dated the same date as the bid and executed by all partners of the firm.

6.2 Bids that are signed for a corporation shall have the correct corporate name thereon and the signature of an authorized officer of the corporation manually written below corporate name. Title of office held by the person signing for the corporation shall appear below the signature of the officer.

6.3 Bids that are signed by an individual doing business under a firm name, shall be manually signed in the name of the individual doing business under the proper firm name and style.

6.4 Bids that are signed under joint venture shall be manually signed by officers of the firms having authority to sign for their firm.

7. Bid Security

7.1 Each bid shall be accompanied by a bid bond, certified check, or cashier's check, acceptable to and payable without condition to The Curators of the University of Missouri, in an amount at least equal to five percent (5%) of bidder's bid including additive alternates.

7.2 Bid security is required as a guarantee that bidder will enter into a written contract and furnish a performance bond within the time and in form as specified in these specifications; and if successful bidder fails to do so, the bid security will be realized upon or retained by the Owner. The apparent low bidder shall notify the Owner in writing within 48 hours (2 workdays) of the bid opening of any circumstance that may affect the bid security including, but not limited to, a bidding error. This notification will not guarantee release of the bidder's security and/or the bidder from the Bidder's Obligations.

7.3 If a bid bond is given as a bid security, the amount of the bond may be stated as an amount equal to at least five percent (5%) of the bid, including additive alternates, described in the bid. The bid bond shall be executed by the bidder and a responsible surety licensed in the State of Missouri with a Best's rating of no less than A-/XI.

7.4 It is specifically understood that the bid security is a guarantee and shall not be considered as liquidated damages for failure of bidder to execute and deliver their contract and performance bond, nor limit or fix bidder's liability to Owner for any damages sustained because of failure to execute and deliver the required contract and performance bond.

7.5 Bid security of the two (2) lowest and responsive Bidders will be retained by the Owner until a contract has been executed and an acceptable bond has been furnished, as required hereby, when such bid security will be returned. Surety bid bonds of all other bidders will be destroyed and all other alternative forms of bid bonds will be returned to them within ten (10) days after Owner has determined the two (2) lowest and responsive bids.

8. Bidder's Statement of Qualifications

8.1 Each bidder submitting a bid shall present evidence of their experience, qualifications, financial responsibility and ability to carry out the terms of the contract by completing and submitting with their bid the schedule of information set forth in the form furnished in the bid form.

8.2 Such information, a single copy required in a separate sealed envelope, will be treated as confidential information by the Owner, within the meaning of Missouri Statue 610.010.

8.3 Bids not accompanied with current Bidder's Statement of Qualifications may be rejected.

9. Award of Contract

9.1 The Owner reserves the right to let other contracts in connection with the work, including, but not by way of limitation, contracts for furnishing and installation of furniture, equipment, machines, appliances, and other apparatus.

9.2 In awarding the contract, the Owner may take into consideration the bidder's, and their subcontractor's, ability to handle promptly the additional work, skill, facilities, capacity, experience, ability, responsibility, previous work, financial standing of bidder, and the bidder's ability to provide the required bonds and insurance; quality, efficiency and construction of equipment proposed to be furnished; period of time within which equipment is proposed to be furnished and delivered; success in achieving the specified Supplier Diversity goal, or demonstrating a good faith effort as described in Article 15; necessity of prompt and efficient completion of work herein described, and the bidder's status as suspended or debarred. Inability of any bidder to meet the requirements mentioned above may be cause for rejection of their bid.

10. Contract Execution

10.1 The Contractor shall submit within fifteen (15) days from receipt of notice, the documents required in Article 9 of the General Conditions for Construction Contract included in the contract documents.

10.2 No bids will be considered binding upon the Owner until the documents listed above have been furnished. Failure of Contractor to execute and submit these documents within the time period specified will be treated, at the option of the

Owner, as a breach of the bidder's bid security under Article 7 and the Owner shall be under no further obligation to Bidder.

11. Contract Security

11.1 When the Contract sum exceeds $50,000, the Contractor shall procure and furnish a Performance bond and a Payment bond in the form prepared by Owner. Each bond shall be in the amount equal to one hundred percent (100%) of the contract sum, as well as adjustments to the Contract Sum. The Performance Bond shall secure and guarantee Contractor's faithful performance of this Contract, including but not limited to Contractor's obligation to correct defects after final payment has been made as required by the Contract Documents. The Payment Bond shall secure and guarantee payment of all persons performing labor on the Project under this Contract and furnishing materials in connection with this Contract. These Bonds shall be in effect through the duration of the Contract plus the Guaranty Period as required by the Contract Documents.

11.2 The bonds required hereunder shall be meet all requirements of Article 11 of the General Conditions for Construction Contract included in the contract documents.

11.3 If the surety of any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to conduct business in the State of Missouri is terminated, or it ceases to meet the requirements of this Article 11, Contractor shall within ten (10) days substitute another bond and surety, both of which must be acceptable to Owner. If Contractor fails to make such substitution, Owner may procure such required bonds on behalf of Contractor at Contractor's expense.

12. Time of Completion

12.1 Contractors shall agree to commence work within five (5) days of the date "Notice to Proceed" is received from the Owner, and the entire work shall be completed by the completion date specified or within the number of consecutive calendar days stated in the Special Conditions. The duration of the construction period, when specified in consecutive calendar days, shall begin when the contractor receives notice requesting the documents required in Article 9 of the General Conditions for Construction Contract included in the contract documents.

13. Number of Contract Documents

13.1 The Owner will furnish the Contractor a copy of the executed contract and performance bond.

13.2 The Owner will furnish the Contractor the number of copies of complete sets of drawings and specifications for the work, as well as clarification and change order drawings pertaining to change orders required during construction as set forth in the Special Conditions.

14. Missouri Products and Missouri Firms

14.1 The Curators of the University of Missouri have adopted a policy which is binding upon all employees and departments of the University of Missouri, and which by contract, shall be binding upon independent contractors and subcontractors with the University of Missouri whereby all other things being equal, and when the same can be secured without additional cost over foreign products, or products of other states, a preference shall be granted in all construction, repair and purchase contracts, to all products, commodities, materials, supplies, and articles mined, grown, produced, andmanufactured in marketable quantity and quality in the Stateof Missouri, and to all firms, corporations or individuals doing business as Missouri firms, corporations, or individuals. Each bidder submitting a bid agrees to comply with and be bound by the foregoing policy.

15. SUPPLIER DIVERSITY

15.1 Award of Contract

The Supplier Diversity participation goal for this project is stated on the Bid for Lump Sum Contract Form, and the Owner will take into consideration the bidder's success in achieving the Supplier Diversity participation goal in awarding the contract. Inability of any bidder to meet this requirement may be cause for rejection of their bid.

A 3-point Service-Disabled Veteran Enterprises (SDVE) bonus preference shall apply to this contract. The 3 bonus points can be obtained by a certified, Missouri based SDVE performing a commercially useful function, (as defined in Article 1 of the General Conditions of the Contract for Construction) either by submitting a bid directly to the Owner, or through the utilization of certified SDVE subcontractors and/or suppliers, whose participation provides atleast 3% of the total bid amount. A firm does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction, contract, or project through which funds are passed in order to obtain the appearance of SDVE participation. In determining whether a firm is such an extra participant, the Owner will examine similar transactions, particularly those in which SDVEs do not participate. The 3-point bonus preference shall be calculated and applied by reducing the bid amount of the eligible bidder by three (3) percent of the apparent low responsive bidder's bid. Based on this calculation, if the eligible bidder's resulting total bid valuation is less than the apparent low responsive bidder's bid, the eligible bid becomes the apparent low responsive bid. This reduction is for evaluation purposes only and will have no impact on the actual amount(s) of the eligible bidder's bid or the amount(s) of any contract awarded. The submitted bid form must include a minimum of 3% SDVE participation to obtain the three (3) point bonus. For every SDVE firm utilized, a completed AFFIDAVIT OF SUPPLIER DIVERSITY PARTICIPATION form shall be submitted to the Owner within 24 hours of the receipt of bids. Failure to do so may be grounds for rejection of the SDVE bonus preference.

15.2 List of Supplier Diversity Firms

15.2.1 The bidder shall submit as part of their bid a list of diverse firms performing as contractor, subcontractors, and/or suppliers. The list shall specify the single designated diverse firm name and address. If acceptance or non-acceptance of alternates will affect the designation of a subcontractor, provide information for each affected category.

15.2.2 Failure to include a complete list of diverse firms may be grounds for rejection of the bid.

15.2.3 The list of diverse firms shall be submitted in addition to any other listing of subcontractors required in the Bid for Lump Sum Contract Form.

15.3 Supplier Diversity Percentage Goal

The bidder shall have a minimum goal of subcontracting with diverse contractors, subcontractors, and suppliers, the percent

of contract price stated in the Supplier Diversity goal paragraph of the Bid for Lump Sum Contract Form.

.

15.4 Supplier Diversity Percent Goal Computation

15.4.1 The total dollar value of the work granted to the diverse firms by the successful bidder is counted towards the applicable goal of the entire contract, unless otherwise noted below.

15.4.2 The bidder may count toward the Supplier Diversity goal only expenditures to diverse firms that perform a commercially useful function in the work of a contract. A diverse firm is considered to perform a commercially useful function when it is responsible for executing a distinct element of the work and carrying out its responsibilities by actually performing, managing and supervising the work involved. A bidder that is a certified diverse firm may count as 100% of the contract towards the Supplier Diversity goal. For projects with separate MBE, SDVE, and WBE/Veteran/DBE goals, a MBE firm bidding as the prime bidder is expected to obtain the required SDVE, and WBE/Veteran/ DBE participation; a WBE or Veteran or DBE firm bidding as the prime bidder is expected to obtain the required MBE and SDVE participation and a SDVE firm bidding as the prime bidder is expected to obtain the required MBE, and WBE/Veteran/ DBE participation.

15.4.3 When a MBE, WBE, Veteran Business Enterprise, DBE, or SDVE performs work as a participant in a joint venture, only the portion of the total dollar value of the contract equal to the distinct, clearly defined portion of the work of the contract that the MBE, WBE, Veteran Business Enterprise, DBE, or SDVE performs with its own forces shall count toward the MBE, WBE, Veteran Business Enterprise, DBE, or SDVE individual contract percentages.

15.4.4 The bidder may count toward its Supplier Diversity goal expenditures for materials and supplies obtained from diverse suppliers and manufacturers, provided the diverse firm assumes the actual and contractual responsibility for the provision of the materials and supplies.

15.4.4.1 The bidder may count its entire expenditure to a diverse manufacturer. A manufacturer shall be defined as an individual or firm that produces goods from raw materials or substantially alters them before resale.

15.4.4.2 The bidder may count its entire expenditure to diverse suppliers that are not manufacturers provided the diverse supplier performs a commercially useful function as defined above in the supply process.

15.4.4.3 The bidder may count 25% of its entire expenditures to diverse firms that do not meet the definition of a subcontractor, a manufacturer, nor a supplier. Such diverse firms may arrange for, expedite, or procure portions of the work but are not actively engaged in the business of performing, manufacturing, or supplying that work.

15.4.5 The bidder may count toward the Supplier Diversity goal that portion of the total dollar value of the work awarded to a certified joint venture equal to the percentage of the ownership and control of the diverse partner in the joint venture.

15.5 Certification by Bidder of Diverse Firms

15.5.1. The bidder shall submit with its bid the information requested in the "Supplier Diversity Compliance Evaluation Form" for every diverse firm the bidder intends to award work to on the contract.

15.5.2. Diverse firms are defined in Article 1 – (Supplier Diversity Definitions) of the General Conditions of the Contract for Construction included in the contract documents, and as those businesses certified as disadvantaged by an approved agency. The bidder is responsible for obtaining information regarding the certification status of a firm. A listof certified firms may be obtained by contacting the agencies listed in the proposal form document "Supplier Diversity Certifying Agencies." Any firm listed as disadvantaged by any of the identified agencies will be classified as a diverse firm by the Owner.

15.5.3. Bidders are urged to encourage their prospective diverse contractors, subcontractors, joint venture participants, team partners, and suppliers who are not currently certified to obtain certification from one of the approved agencies.

15.6 Supplier Diversity Participation Waiver

15.6.1 The bidder is required to make a good faith effort to locate and contract with diverse firms. If a bidder has made a good faith effort to secure the required diverse firms and has failed, the bidder shall submit with the bid, the information requested in "Application for Supplier Diversity Participation Waiver." The Contracting Officer will review the bidder's actions as set forth in the bidder's "Application for Waiver" and any other factors deemed relevant by the Contracting Officer to determine if a good faith effort has been made to meet the applicable percentage goal. If the bidder is judged not to have made a good faith effort, the bid may be rejected. Bidders who demonstrate that they have made a good faith effort to include Supplier Diversity participation may be awarded the contract regardless of the percent of Supplier Diversity participation, provided the bid is otherwise acceptable and is determined to be the best bid.

15.6.2 To determine good faith effort of the bidder, the Contracting Officer may evaluate factors including, but not limited to, the following:

15.6.2.1 The bidder's attendance at pre-proposal meetings scheduled to inform bidders and diverse firms of contracting and subcontracting opportunities and responsibilities associated with Supplier Diversity participation.

15.6.2.2 The bidder's advertisements in general circulation trade association, and diverse (minority) focused media concerning subcontracting opportunities.

15.6.2.3 The bidder's written notice to specific diverse firms that their services were being solicited in sufficient time to allow for their effective participation.

15.6.2.4 The bidder's follow-up attempts to the initial solicitation(s) to determine with certainty whether diverse firms were interested.

15.6.2.5 The bidder's efforts to divide the work into packages suitable for subcontracting to diverse firms.

15.6.2.6 The bidder's efforts to provide interested diverse firms with sufficiently detailed information about the drawings, specific actions and requirements of the contract, and clear scopes of work for the firms to bid on.

15.6.2.7 The bidder's efforts to solicit for specific sub-bids from diverse firms in good faith. Documentation should include names, addresses, and telephone numbers of firms contacted a description of all information provided the diverse firms, and an explanation as to why agreements were not reached.

15.6.2.8 The bidder's efforts to locate diverse firms not on the directory list and assist diverse firms in becoming certified as such.

15.6.2.9 The bidder's initiatives to encourage and develop participation by diverse firms.

15.6.2.10 The bidder's efforts to help diverse firms overcome legal or other barriers impeding the participation of diverse firms in the construction contract.

15.6.2.11 The availability of diverse firms and the adequacy of the bidder's efforts to increase the participation of such business provided by the persons and organizations consulted by the bidder.

15.7 Submittal of Forms

15.7.1 The bidder will include the Supplier Diversity Compliance Evaluation Form(s), or the Application for Waiver and other form(s) as required above in the envelope containing the "Bidder's Statement of Qualifications", see Article 8.

15.8 Additional Bid/Proposer Information

15.8.1 The Contracting Officer reserves the right to request additional information regarding Supplier Diversity participation and supporting documentation from the apparent low bidder. The bidder shall respond in writing to the Contracting Officer within 24 hours (1 workday) of a request.

15.8.2 The Contracting Officer reserves the right to request additional information after the bidder has responded to prior 24-hour requests. This information may include follow up and/or clarification of the information previously submitted.

15.8.3 The Owner reserves the right to consider additional diverse subcontractor and supplier participation submitted by the bidder after bids are opened under the provisions within these contract documents that describe the Owner's right to accept or reject subcontractors including, but not limited to, Article 16 below. The Owner may elect to waive the good faith effort requirement if such additional participation achieves the Supplier Diversity goal.

15.8.4 The Bidder shall provide the Owner information related to the Supplier Diversity participation included in the bidder's proposal, including, but is not limited to, the complete Application for Waiver, evidence of diverse certification of participating firms, dollar amount of participation of diverse firms, information supporting a good faith effort as described in Article 15.6 above, and a list of all diverse firms that submitted bids to the Bidder with the diverse firm's price and the name and the price of the firm awarded the scope of work bid by the diverse firm.

16. List of Subcontractors

16.1 If a list of subcontractors is required on the Bid for Lump Sum Contract Form, the bidders shall list the name, city and state of the firm(s) which will accomplish that portion of the contract requested in the space provided. This list is separate from both the list of diverse firms required in Article 15.2, and the complete list of subcontractors required in Article 10.1 of this document. Should the bidder choose to perform any of the listed portions of the work with its own forces, the bidder shall enter its own name, city and state in the space provided. If acceptance or non-acceptance of alternates will affect the designation of a subcontractor, the bidder shall provide that information on the bid form.

16.2 Failure of the bidder to supply the list of subcontractors required or the listing of more than one subcontractor for any category without designating the portion of the work to be performed by each, shall be grounds for the rejection of the bid. The bidder can petition the Owner to change a listed subcontractor within 48 hours of the bid opening. The Owner reserves the right to make the final determination on a petition to change a subcontractor. The Owner will consider factors such as clerical and mathematical bidding errors, listed subcontractor's inability to perform the work for the bid used, etc. Any request to change a listed subcontractor shall include at a minimum, contractor's bid sheet showing tabulation of the bid; all subcontractor bids with documentation of the time they were received by the contractor; and a letter from the listed subcontractor on their letterhead stating why they cannot perform the work if applicable. The Owner reserves the right to ask for additional information.

16.3 Upon award of the contract, the requirements of Article 10 of this document and Article 5 of the General Conditions of the Contract for Construction included in the contract documents will apply.

THIS PAGE INTENTIONALLY LEFT BLANK

University of Missouri

General Conditions

of the

Contract

for

Construction

December 2021 Edition

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF ARTICLES

PAGE

1. GENERAL PROVISIONS GC/1

1.1 Basic Definitions GC/1
1.2 Specifications and Drawings GC/3
1.3 Required Provisions Deemed Inserted GC/4

2. OWNER GC/4

2.1 Information and Services Required of the Owner GC/4
2.2 Owner's Right to Stop the Work GC/4
2.3 Owner's Right to Carry Out the Work GC/4
2.4 Extent of Owner Rights GC/5

3. CONTRACTOR GC/5

3.1 Contractor's Warranty GC/5
3.2 Compliance with Laws, Regulations, Permits, Codes, and Inspections GC/5
3.3 Anti-Kickback GC/6
3.4 Supervision and Construction Procedures GC/6
3.5 Use of Site GC/7
3.6 Review of Contract Documents and Field Conditions by Contractor GC/8
3.7 Cleaning and Removal GC/8
3.8 Cutting and Patching GC/8
3.9 Indemnification GC/9
3.10 Patents GC/9
3.11 Delegated Design GC/10
3.12 Materials, Labor, and Workmanship GC/10
3.13 Approved Equal GC/11
3.14 Shop Drawings, Product Data and Samples GC/11
3.15 Record Drawings GC/12
3.16 Operating Instructions and Service Manual GC/13
3.17 Taxes GC/13
3.18 Contractor's Construction Schedules GC/14

4. ADMINISTRATION OF THE CONTRACT GC/14

4.1 Rights of the Owner GC/14
4.2 Rights of the Architect GC/15
4.3 Review of the Work GC/15
4.4 Claims GC/15
4.5 Claims for Concealed or Unknown Conditions GC/15
4.6 Claim for Additional Cost GC/16
4.7 Claims for Additional Time GC/16
4.8 Resolution of Claims and Disputes GC/17
4.9 Administrative Review GC/17

5. SUBCONTRACTORS GC/17

5.1 Award of Subcontracts GC/17
5.2 Subcontractual Relations GC/18
5.3 Contingent Assignment of Subcontract GC/18

6. SEPARATE CONTRACTS AND COOPERATION GC/18

7. CHANGES IN THE WORK GC/19
7.1 Change Orders GC/19
7.2 Construction Change Directive GC/20
7.3 Overhead and Profit GC/20
7.4 Extended General Conditions GC/21
7.5 Emergency Work GC/21

8. TIME GC/21

8.1 Progress and Completion GC/21
8.2 Delay in Completion GC/21
8.3 Liquidated Damages GC/22

9. PAYMENTS AND COMPLETION GC/22

9.1 Commencement, Prosecution and Completion GC/22
9.2 Contract Sum GC/23
9.3 Schedule of Values GC/24
9.4 Applications for Payment GC/24
9.5 Approval for Payment GC/25
9.6 Decisions to Withhold Approval GC/25
9.7 Progress Payments GC/25
9.8 Failure of Payment GC/26
9.9 Substantial Completion GC/26
9.10 Partial Occupancy or Use GC/26
9.11 Final Completion and Final Payment GC/26

10. PROTECTION OF PERSONS AND PROPERTY GC/27

10.1 Safety Precautions and Programs GC/27
10.2 Safety of Persons and Property GC/27

11. INSURANCE & BONDS GC/28

11.1 Insurance GC/28
11.2 Commercial General Liability GC/28
11.3 Licensed for Use Vehicle Liability GC/29
11.4 Workers' Compensation Insurance GC/29
11.5 Liability Insurance General Requirements GC/29
11.6 Builder's Risk Insurance GC/30
11.7 Bonds GC/31

12. UNCOVERING AND CORRECTION OF THE WORK GC/32

12.1 Uncovering of the Work GC/32
12.2 Correction of the Work GC/32
12.3 Acceptance of Nonconforming Work GC/32

13. MISCELLANEOUS PROVISIONS GC/33

13.1 Written Notice GC/33
13.2 Rights and Remedies GC/33
13.3 Tests and Inspections GC/33
13.4 Nondiscrimination in Employment Equal Opportunity GC/33
13.5 Supplier Diversity Goal Program GC/34
13.6 Wage Rates GC/34
13.7 Records GC/36
13.8 Codes and Standards GC/36
13.9 General Provisions GC/37
13.10 Certification GC/37

14. TERMINATION OR SUSPENSION OF THE CONTRACT GC/38

14.1 Termination by Owner for Cause GC/38
14.2 Suspension by the Owner for Convenience GC/38
14.3 Owner's Termination for Convenience GC/38

ARTICLE 1
GENERAL PROVISIONS

1.1 Basic Definitions
As used in the Contract Documents, the following terms shall have the meanings and refer to the parties designated in these definitions.

1.1.1 Owner
The Curators of the University of Missouri. The Owner may act through its Board of Curators or any duly authorized committee or representative thereof.

1.1.2 Contracting Officer
The Contracting Officer is the duly authorized representative of the Owner with the authority to execute contracts. Communications to the Contracting Officer shall be forwarded via the Owner's Representative.

1.1.3 Owner's Representative
The Owner's Representative is authorized by the Owner as the administrator of the Contract and will represent the Owner during the progress of the Work. Communications from the Architect to the Contractor and from the Contractor to the Architect shall be through the Owner's Representative, unless otherwise indicated in the Contract Documents.

1.1.4 Architect
When the term "Architect" is used herein, it shall refer to the Architect or the Engineer specified and defined in the Contract for Construction or its duly authorized representative. Communications to the Architect shall be forwarded to the address shown in the Contract for Construction.

1.1.5 Owner's Authorized Agent
When the term "Owner's Authorized Agent" is used herein, it shall refer to an employee or agency acting on the behalf of the Owner's Representative to perform duties related to code inspections, testing, operational systems check, certification or accreditation inspections, or other specialized work.

1.1.6 Contractor
The Contractor is the person or entity with whom the Owner has entered into the Contract for Construction. The term "Contractor" means the Contractor or the Contractor's authorized representative.

1.1.7 Subcontractor and Lower-tier Subcontractor
A Subcontractor is a person or organization who has a contract with the Contractor to perform any of the Work. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or its authorized representative. The term "Subcontractor" also is applicable to those furnishing materials to be incorporated in the Work whether work performed is at the Owner's site or off site, or both. A lower-tier Subcontractor is a person or organization who has a contract with a Subcontractor or another lower-tier Subcontractor to perform any of the Work at the site. Nothing contained in the Contract Documents shall create contractual relationships between the Owner or the Architect and any Subcontractor or lower-tier Subcontractor of any tier.

1.1.8 Supplier Diversity Definitions
Businesses that fall into the Supplier Diversity classification shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more diverse suppliers as described below.

.1 Minority Business Enterprises (MBE)

Minority Business Enterprise [MBE] shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more minorities as defined below or, in the case of any publicly-owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more minorities as defined below, and whose management and daily business operations are controlled by one (1) or more minorities as defined herein.

- **.1.1** "African Americans", which includes persons having origins in any of the black racial groups of Africa.
- **.1.2** "Hispanic Americans", which includes persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race.
- **.1.3** "Native Americans", which includes persons of American Indian, Eskimo, Aleut, or Native Hawaiian origin.
- **.1.4** "Asian-Pacific Americans", which includes persons whose origins are from Japan, China, Taiwan, Korea, Vietnam, Laos, Cambodia, the Philippines, Samoa, Guam, the U.S. Trust Territories of the Pacific, or the Northern Marinas.
- **.1.5** "Asian-Indian Americans", which includes persons whose origins are from India, Pakistan, or Bangladesh.

.2 Women Business Enterprise (WBE)

Women Business Enterprise [WBE] shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more women or, in the case of any publicly owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more women, and whose management and daily business operations are controlled by one (1) or more women.

.3 Veteran Owned Business

Veteran Owned Business shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more Veterans or, in the case of any publicly owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more Veterans, and whose management and daily business operations are controlled by one (1) or more Veterans. Veterans must be certified by the appropriate federal agency responsible for veterans' affairs.

.4 Service-Disabled Veteran Enterprise (SDVE)
Service-Disabled Veteran Enterprise (SDVE) shall mean a business certified by the State of Missouri Office of Administration as a Service-Disabled Veteran Enterprise, which is at least fifty-one percent (51%) owned and controlled by one (1) or more Serviced-Disabled Veterans or, in the case of any publicly-owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more Service-Disabled Veterans, and whose management and daily business operations are controlled by one (1) or more Serviced-Disabled Veterans.

.5 Disadvantaged Business Enterprise (DBE)
A Disadvantaged Business Enterprise (DBE) is a for-profit small business concern where a socially and economically disadvantaged individual owns at least 51% interest and also controls management and daily business operations. These firms can and also be referred to as Small Disadvantaged Businesses (SDB). Eligibility requirements for certification are stated in 49 CFR (Code of Federal Regulations), part 26, Subpart D.

U.S. citizens that are African Americans, Hispanics, Native Americans, Asian-Pacific and Subcontinent Asian Americans, and women are presumed to be socially and economically disadvantaged. Also recognized as DBE's are Historically Black Colleges and Universities (HBCU) and small businesses located in Federal HUB Zones.
To be regarded as economically disadvantaged, an individual must have a personal net worth that does not exceed $1.32 million. To be seen as a small business, a firm must meet Small Business Administration (SBA) size criteria (500 employees or less) and have average annual gross receipts not to exceed $22.41 million. To be considered a DBE/SDB, a small business owned and controlled by socially and/or economically disadvantaged individuals must receive DBE certification from one of the recognized Missouri state agencies to be recognized in this classification.

1.1.9 Work
Work shall mean supervision, labor, equipment, tools, material, supplies, incidentals operations and activities required by the Contract Documents or reasonably inferable by Contractor therefrom as necessary to produce the results intended by the Contract Documents in a safe, expeditious, orderly, and workmanlike manner, and in the best manner known to each respective trade.

1.1.10 Approved
The terms "approved", "equal to", "directed", "required", "ordered", "designated", "acceptable", "compliant", "satisfactory", and similar words or phrases will be understood to have reference to action on the part of the Architect and/or the Owner's Representative.

1.1.11 Contract Documents
The Contract Documents consist of (1) the executed Contract for Construction, (2) these General Conditions of the Contract for Construction, (3) any Supplemental Conditions or Special Conditions identified in the Contract for Construction, (4) the Specifications identified in the Contract for Construction, (5) the Drawings identified in the Contract for Construction, (6) Addenda issued prior to the receipt of bids, (7) Contractor's bid addressed to Owner, including Contractor's completed Qualification Statement, (8) Contractor's Performance Bond and Contractor's Payment Bond, (9) Notice to Proceed, (10) and any other exhibits and/or post bid adjustments identified in the Contract for Construction, (11) Advertisement for Bid, (12) Information for Bidders, and (13) Change Orders issued after execution of the Contract. All other documents and technical reports and information are not Contract Documents, including without limitation, Shop Drawings, and Submittals.

1.1.12 Contract
The Contract Documents form the Contract and are the exclusive statement of agreement between the parties. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior representations or agreements, either written or oral. The Contract Documents shall not be construed to create a contractual relationship of any kind between the Owner and a Subcontractor or any lower-tier Subcontractor.

1.1.13 Change Order
The Contract may be amended or modified without invalidating the Contract, only by a Change Order, subject to the limitations in Article 7 and elsewhere in the Contract Documents. A Change Order is a written instrument signed by the Owner and the Contractor stating their agreement to a change in the Work, the amount of the adjustment to the Contract Sum, if any, and the extent of the adjustment to the Contract Time, if any. Agreement to any Change Order shall constitute a final settlement of all matters relating to the change in the work which is the subject of the Change Order, including, but not limited to, all direct and indirect costs associated with such change and any and all adjustments of the Contract sum, time and schedule.

1.1.14 Substantial Completion
The terms "Substantial Completion" or "substantially complete" as used herein shall be construed to mean the completion of the entire Work, including all submittals required under the Contract Documents, except minor items which in the opinion of the Architect, and/or the Owner's Representative will not interfere with the complete and satisfactory use of the facilities for the purposes intended.

1.1.15 Final Completion
The date when all punch list items are completed, including all closeout submittals and approval by the Architect is given to the Owner in writing.

1.1.16 Supplemental and Special Conditions
The terms "Supplemental Conditions" or "Special Conditions" shall mean the part of the Contract Documents

which amend, supplement, delete from, or add to these General Conditions.

1.1.17 Day
The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

1.1.18 Knowledge.
The terms “knowledge,” “recognize” and “discover” their respective derivatives and similar terms in the Contract Documents, as used in reference to the Contractor, shall be interpreted to mean that which the Contractor knows or should know, recognizes, or should recognize and discovers or should discover in exercising the care, skill, and diligence of a diligent and prudent contractor familiar with the work. Analogously, the expression “reasonably inferable” and similar terms in the Contract Documents shall be interpreted to mean reasonably inferable by a diligent and prudent contractor familiar with the work.

1.1.19 Punch List
“Punch List” means the list of items, prepared in connection with the inspection(s) of the Project by the Owner’s Representative or Architect in connection with Substantial Completion of the Work or a portion of the Work, which the Owner’s Representative or Architect has designated as remaining to be performed, completed, or corrected before the Work will be accepted by the Owner.

1.1.20 Public Works Contracting Minimum Wage
The public works contracting minimum wage shall be equal to one hundred twenty percent of the average hourly wage in a particular locality, as determined by the Missouri economic research and information center within the department of economic development, or any successor agency.

1.1.21 Force Majeure
An event or circumstance that could not have been reasonably anticipated and is out of the control of both the Owner and the Contractor.

1.2 Specifications and Drawings
1.2.1 The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, construction system, standards and workmanship and performance of related services for the Work identified in the Contract for Construction. Specifications are separated into titled divisions for convenience of reference only. Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade. Such separation will not operate to make the Owner or the Architect an arbiter of labor disputes or work agreements.

1.2.2 The drawings herein referred to, consist of drawings prepared by the Architect and are enumerated in the Contract Documents.

1.2.3 Drawings are intended to show general arrangements, design, and dimensions of work and are partly diagrammatic. Dimensions shall not be determined by scale or rule. If figured dimensions are lacking, they shall be supplied by the Architect on the Contractor's written request to the Owner's Representative.

1.2.4 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complimentary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall by required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the intended results.

1.2.5 In the event of inconsistencies within or between parts of the Contract Documents, or between the Contract Documents and applicable standards, codes and ordinances, the Contractor shall (1) provide the better quality or greater quantity of Work or (2) comply with the more stringent requirement; either or both in accordance with the Owner’s Representative’s interpretation. On the Drawings, given dimensions shall take precedence over scaled measurements and large-scale drawings over small scale drawings. Before ordering any materials or doing any Work, the Contractor and each Subcontractor shall verify measurements at the Work site and shall be responsible for the correctness of such measurements. Any difference which may be found shall be submitted to the Owner’s Representative and Architect for resolution before proceeding with the Work. If a minor change in the Work is found necessary due to actual field conditions, the Contractor shall submit detailed drawings of such departure for the approval by the Owner’s Representative and Architect before making the change.

1.2.6 Data in the Contract Documents concerning lot size, ground elevations, present obstructions on or near the site, locations and depths of sewers, conduits, pipes, wires, etc., position of sidewalks, curbs, pavements, etc., and nature of ground and subsurface conditions have been obtained from sources the Architect believes reliable, but the Architect and Owner do not represent or warrant that this information is accurate or complete. The Contractor shall verify such data to the extent possible through normal construction procedures, including but not limited to contacting utility owners and by prospecting.

1.2.7 Only work included in the Contract Documents is authorized, and the Contractor shall do no work other than that described therein.

1.2.8 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become familiar with local conditions under which the Work is to be

performed and correlated personal observations with requirements of the Contract Documents. Contractor represents that it has performed its own investigation and examination of the Work site and its surroundings and satisfied itself before entering into this Contract as to:

.1 conditions bearing upon transportation, disposal, handling, and storage of materials;

.2 the availability of labor, materials, equipment, water, electrical power, utilities and roads;

.3 uncertainties of weather, river stages, flooding and similar characteristics of the site;

.4 conditions bearing upon security and protection of material, equipment, and Work in progress;

.5 the form and nature of the Work site, including the surface and sub-surface conditions;

.6 the extent and nature of Work and materials necessary for the execution of the Work and the remedying of any defects therein; and

.7 the means of access to the site and the accommodations it may require and, in general, shall be deemed to have obtained all information as to risks, contingencies and other circumstances.

.8 the ability to complete work without disruption to normal campus activities, except as specifically allowed in the contract documents.

The Owner assumes no responsibility or liability for the physical condition or safety of the Work site or any improvements located on the Work site. The Contractor shall be solely responsible for providing a safe place for the performance of the Work. The Owner shall not be required to make any adjustment in either the Contract Sum or Contract Time concerning any failure by the Contractor or any Subcontractor to comply with the requirements of this Paragraph.

1.2.9 Drawings, specifications, and copies thereof furnished by the Owner are and shall remain the Owner's property. They are not to be used on another project and, with the exception of one contract set for each party to the Contract, shall be returned to the Owner's Representative on request, at the completion of the Work.

1.3 Required Provisions Deemed Inserted

Each and every provision of law and clause required by law to be inserted in this Contract shall be deemed to be inserted herein, and the Contract shall be read and enforced as though it were included herein; and if through mistake or otherwise any such provision is not inserted, or is not correctly inserted, then upon the written application of either party the Contract shall forthwith be physically amended to make such insertion or correction.

ARTICLE 2
OWNER

2.1 Information and Services Required of Owner

2.1.1 Permits and fees are the responsibility of the Contractor under the Contract Documents, unless specifically stated in the contract documents that the Owner will secure and pay for specific necessary approvals, easements, assessments, and charges required for construction, use or occupancy of permanent structures, or for permanent changes in existing facilities.

2.1.2 When requested in writing by the Contractor, information or services under the Owner's control, which are reasonably necessary to perform the Work, will be furnished by the Owner with reasonable promptness to avoid delay in the orderly progress of the Work.

2.2 Owner's Right to Stop the Work

2.2.1 If the Contractor fails to correct Work which is not in strict accordance with the requirements of the Contract Documents or fails to carry out Work in strict accordance with the Contract Documents, the Owner's Representative may order the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work will not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity. Owner's lifting of Stop Work Order shall not prejudice Owner's right to enforce any provision of this Contract.

2.3 Owner's Right to Carry Out the Work

2.3.1 If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a seven (7) day period after receipt of a written notice from the Owner to correct such default or neglect, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. In such case, an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the cost of correcting such deficiencies, including compensation for the Architect's additional services and expenses made necessary by such default or neglect. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to Owner. However, such notice shall be waived in the event of an emergency with the potential for property damage or the endangerment of students, faculty, staff, the public or construction personnel, at the sole discretion of the Owner.

2.3.2 In the event the Contractor has not satisfactorily completed all items on the Punch List within thirty (30) days of its receipt, the Owner reserves the right to complete the Punch List without further notice to the Contractor or its surety. In such case, Owner shall be entitled to deduct from payments then or thereafter due the Contractor the cost of completing the Punch List items, including compensation for the Architect's additional services. If payments then or

thereafter due Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to Owner.

2.4 Extent of Owner Rights

2.4.1 The rights stated in this Article 2 and elsewhere in the Contract Documents are cumulative and not in limitation of any rights of the Owner (1) granted in the Contract Documents, (2) at law or (3) in equity.

2.4.2 In no event shall the Owner have control over, charge of, or any responsibility for construction means, methods, techniques, sequences or procedures or for safety precautions and programs in connection with the Work, notwithstanding any of the rights and authority granted the Owner in the Contract Documents.

ARTICLE 3
CONTRACTOR

3.1 Contractor's Warranty

3.1.1 The Contractor warrants all equipment and materials furnished, and work performed, under this Contract, against defective materials and workmanship for a period of twelve months after acceptance as provided in this Contract, unless a longer period is specified, regardless of whether the same were furnished or performed by the Contractor or any Subcontractors of any tier. Upon written notice from the Owner of any breech of warranty during the applicable warranty period due to defective material or workmanship, the affected part or parts thereof shall be repaired or replaced by the Contractor at no cost to the Owner. Should the Contractor fail or refuse to make the necessary repairs, replacements, and tests when requested by the Owner, the Owner may perform, or cause the necessary work and tests to be performed, at the Contractor's expense, or exercise the Owner's rights under Article 14.

3.1.2 Should one or more defects mentioned above appear within the specified period, the Owner shall have the right to continue to use or operate the defective part or apparatus until the Contractor makes repairs or replacements or until such time as it can be taken out of service without loss or inconvenience to the Owner.

3.1.3 The above warranties are not intended as a limitation but are in addition to all other express warranties set forth in this Contract and such other warranties as are implied by law, custom, and usage of trade. The Contractor, and its surety or sureties, if any, shall be liable for the satisfaction and full performance of the warranties set forth herein.

3.1.4 Neither the final payment nor any provision in the Contract Documents nor partial or entire occupancy of the premises by the Owner, nor expiration of warranty stated herein, will constitute an acceptance of Work not done in accordance with the Contract Documents or relieve the Contractor of liability in respect to any responsibility for non-conforming work. The Contractor shall immediately remedy any defects in the Work and pay for any damage to other Work resulting therefrom upon written notice from the Owner. Should the Contractor fail or refuse to remedy the non-conforming work, the Owner may perform, or cause to be performed the work necessary to bring the work into conformance with the Contract Documents at the Contractor's expense.

3.1.5 The Contractor agrees to defend, indemnify, and save harmless The Curators of the University of Missouri, their Officers, Agents, Employees and Volunteers, from and against all loss or expense from any injury or damages to property of others suffered or incurred on account of any breech of the aforesaid obligations and covenants. The Contractor agrees to investigate, handle, respond to and provide defense for and defend against any such liability, claims, and demands at the sole expense of the Contractor, or at the option of the University, agrees to pay to or reimburse the University for the defense costs incurred by the University in connection with any such liability claims, or demands. The parties hereto understand and agree that the University is relying on and does not waive or intend to waive by any provision of this Contract, any monetary limitations or any other rights, immunities, and protections provided by the State of Missouri, as from time to time amended, or otherwise available to the University, or its officers, employees, agents or volunteers.

3.2 Compliance with Laws, Regulations, Permits, Codes, and Inspections

3.2.1 The Contractor shall, without additional expense to the Owner, comply with all applicable laws, ordinances, rules, permit requirements, codes, statutes, and regulations (collectively referred to as “Laws”).

3.2.2 Since the Owner is an instrumentality of the State of Missouri, municipal, or political subdivision, ordinances, zoning ordinances, and other like ordinances are not applicable to construction on the Owner's property, and the Contractor will not be required to submit plans and specifications to any municipal or political subdivision authority to obtain construction permits or any other licenses or permits from or submit to, inspection by any municipality or political subdivision relating to the construction on the Owner's property, unless required by the Owner in these Contract Documents or otherwise in writing.

3.2.3 All fees, permits, inspections, or licenses required by municipality or political subdivision for operation on property not belonging to the Owner, shall be obtained by and paid for by the Contractor. The Contractor, of its own expense, is responsible to ensure that all inspections required by said permits or licenses on property, easements, or utilities not belonging to the Owner are conducted as required therein. All connection charges, assessments or transportation fees as may be imposed by any utility company or others are

included in the Contract Sum and shall be the Contractor's responsibility, as stated in 2.1.1 above.

3.2.4 If the Contractor has knowledge that any Contract Documents are at variance with any Laws, including Americans with Disabilities Act – Standards for Accessible Design, ordinances, rules, regulations, or codes applying to the Work, Contractor shall promptly notify the Architect and the Owner's Representative, in writing, and any necessary changes will be adjusted as provided in the Contract Documents. However, it is not the Contractor's primary responsibility to ascertain that the Contract Documents are in accordance with applicable Laws, unless such Laws bear upon performance of the Work.

3.3 Anti-Kickback

3.3.1 No member or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this Contract or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this Contract if made with a corporation for its general benefit.

3.3.2 No official of the Owner who is authorized in such capacity and on behalf of the Owner to negotiate, make, accept or approve, or to take part in negotiating, making, accepting, or approving any architectural, engineering, inspection, construction, or material supply contract or any Subcontract of any tier in connection with the construction of the Work shall have a financial interest in this Contract or in any part thereof, any material supply contract, Subcontract of any tier, insurance contract, or any other contract pertaining to the Work.

3.4 Supervision and Construction Procedures

3.4.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for and have control over construction means, methods, techniques, sequences, and procedures and for coordinating all portions of the Work under the Contract. The Contractor shall supply sufficient and competent supervision and personnel, and sufficient material, plant, and equipment to prosecute the Work with diligence to ensure completion thereof within the time specified in the Contract Documents, and shall pay when due any laborer, Subcontractor of any tier, or supplier.

3.4.2 The Contractor, if an individual, shall give the Work an adequate amount of personal supervision, and if a partnership or corporation or joint venture the Work shall be given an adequate amount of personal supervision by a partner or executive officer, as determined by the Owner's Representative.

3.4.3 The Contractor and each of its Subcontractors of any tier shall submit to the Owner such schedules of quantities and costs, progress schedules in accordance with 3.17.2 of this document, payrolls, reports, estimates, records, and other data as the Owner may request concerning Work performed or to be performed under the Contract.

3.4.4 The Contractor shall be represented at the site by a competent superintendent from the beginning of the Work until its final acceptance, whenever contract work is being performed, unless otherwise permitted in writing by the Owner's Representative. The superintendent for the Contractor shall exercise general supervision over the Work and such superintendent shall have decision making authority of the Contractor. Communications given to the superintendent shall be binding as if given to the Contractor. The superintendent shall not be changed by the contractor without approval from the Owner's Representative.

3.4.5 The Contractor shall establish and maintain a permanent benchmark to which access may be had during progress of the Work, and Contractor shall establish all lines and levels, and shall be responsible for the correctness of such. Contractor shall be fully responsible for all layout work for the proper location of Work in strict accordance with the Contract Documents.

3.4.6 The Contractor shall establish and be responsible for wall and partition locations. If applicable, separate contractors shall be entitled to rely upon these locations and for setting their sleeves, openings, or chases.

3.4.7 The Contractor's scheduled outage/tie-in plan, time, and date for any utilities is subject to approval by the Owner's Representative. Communication with the appropriate entity and planning for any scheduled outage/tie-in of utilities shall be the responsibility of the Contractor. Failure of Contractor to comply with the provisions of this Paragraph shall cause Contractor to forfeit any right to an adjustment of the Contract Sum or Contract Time for any postponement, rescheduling or other delays ordered by Owner in connection with such Work. The Contractor shall follow the following procedures for all utility outages/tie-ins or disruption of any building system:

.1 All shutting of valves, switches, etc., shall be by the Owner's personnel.

.2 Contractor shall submit its preliminary outage/tie-in schedule with its baseline schedule.

.3 The Contractor shall request an outage/tie-in meeting at least two weeks before the outage/tie-in is required.

.4 The Owner's Representative will schedule an outage/tie-in meeting at least one week prior to the outage/tie-in.

3.4.8 The Contractor shall coordinate all Work so there shall be no prolonged interruption of existing utilities, systems, and equipment of Owner. Any existing plumbing, heating, ventilating, air conditioning, or electrical disconnection necessary, which affect portions of this construction or building or any other building, must be scheduled with the Owner's Representative to avoid any

disruption of operation within the building under construction or other buildings or utilities. In no case shall utilities be left disconnected at the end of a workday or over a weekend. Any interruption of utilities, either intentionally or accidentally, shall not relieve the Contractor from repairing and restoring the utility to normal service. Repairs and restoration shall be made before the workers responsible for the repair and restoration leave the job.

3.4.9 The Contractor shall be responsible for repair of damage to property on or off the project occurring during construction of project, and all such repairs shall be made to meet code requirements or to the satisfaction of the Owner's Representative if code is not applicable.

3.4.10 The Contractor shall be responsible for all shoring required to protect its work or adjacent property and shall pay for any damage caused by failure to shore or by improper shoring or by failure to give proper notice. Shoring shall be removed only after completion of permanent supports.

3.4.11 The Contractor shall maintain at his own cost and expense, adequate, safe and sufficient walkways, platforms, scaffolds, ladders, hoists and all necessary, proper, and adequate equipment, apparatus, and appliances useful in carrying on the Work and which are necessary to make the place of Work safe and free from avoidable danger for students, faculty, staff, the public and construction personnel, and as may be required by safety provisions of applicable laws, ordinances, rules regulations and building and construction codes.

3.4.12 During the performance of the Work, the Contractor shall be responsible for providing and maintaining warning signs, lights, signal devices, barricades, guard rails, fences, and other devices appropriately located on site which shall give proper and understandable warning to all persons of danger of entry onto land, structure, or equipment, within the limits of the Contractor's work area.

3.4.13 The Contractor shall pump, bail, or otherwise keep any general excavations free of water. The Contractor shall keep all areas free of water before, during and after concrete placement. The Contractor shall be responsible for protection, including weather protection, and proper maintenance of all equipment and materials installed, or to be installed by him.

3.4.14 The Contractor shall be responsible for care of the Work and must protect same from damage of defacement until acceptance by the Owner. All damaged or defaced Work shall be repaired or replaced to the Owner's satisfaction, without cost to the Owner.

3.4.15 When requested by the Owner's Representative, the Contractor, at no extra charge, shall provide scaffolds or ladders in place as may be required by the Architect or the Owner for examination or inspection of Work in progress or completed.

3.4.16 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors of any tier and their agents and employees, and any entity or other persons performing portions of the Work.

3.4.17 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Owner's Representative or Architect in their administration of the Contract, or by tests, inspections or approvals required or performed by persons other than the Contractor.

3.4.18 The Contractor shall be responsible for inspection of portions of the Work already performed under this Contract to determine that such portions are compliant and in proper condition to receive subsequent Work.

3.5 Use of Site

3.5.1 The Contractor shall limit operations and storage of material to the area within the Work limit lines shown on Drawings, except as necessary to connect to exiting utilities, shall not encroach on neighboring property, and shall exercise caution to prevent damage to existing structures.

3.5.2 Only materials and equipment, which are to be used directly in the Work, shall be brought to and stored on the Work site by the Contractor. After equipment is no longer required for the Work, it shall be promptly removed from the Work site. Protection of construction materials and equipment stored at the Work site from weather, theft, damage and all other adversity is solely the responsibility of the Contractor.

3.5.3 No project signs shall be erected without the written approval of the Owner's Representative.

3.5.4 The Contractor shall ensure that the Work is at all times performed in a manner that affords reasonable access, both vehicular and pedestrian, to the site of the Work and all adjacent areas. Particular attention shall be paid to access for emergency vehicles, including fire trucks. Wherever there is the possibility of interfering with normal emergency vehicle operations, Contractor shall obtain permission from both campus and municipal emergency response entities prior to limiting any access. The Work shall be performed, to the fullest extent reasonably possible, in such a manner that public areas adjacent to the site of the Work shall be free from all debris, building materials and equipment likely to cause hazardous conditions. Without limitation of any other provision of the Contract Documents, Contractor shall not interfere with the occupancy or beneficial use of (1) any areas and buildings adjacent to the site of the Work or (2) the Work in the event of partial occupancy. Contractor shall assume full responsibility for any damage to the property

comprising the Work or to the owner or occupant of any adjacent land or areas resulting from the performance of the Work.

3.5.5 The Contractor shall not permit any workers to use any existing facilities at the Work site, including, without limitation, lavatories, toilets, entrances, and parking areas other than those designated by Owner. The Contractor, Subcontractors of any tier, suppliers and employees shall comply with instructions or regulations of the Owner's Representative governing access to, operation of, and conduct while in or on the premises and shall perform all Work required under the Contract Documents in such a manner as not to unreasonably interrupt or interfere with the conduct of Owner's operations. Any request for Work, a suspension of Work or any other request or directive received by the Contractor from occupants of existing buildings shall be referred to the Owner's Representative for determination.

3.5.6 The Contractor and the Subcontractor of any tier shall have its' name, acceptable abbreviation or recognizable logo and the name of the city and state of the mailing address of the principal office of the company, on each motor vehicle and motorized self-propelled piece of equipment which is used in connection with the project. The signs are required on such vehicles during the time the Contractor is working on the project.

3.6 Review of Contract Documents and Field Conditions by Contractor

3.6.1 The Contractor shall carefully study and compare the Contract Documents with each other and with information furnished by the Architect and Owner and shall at once report in writing to the Architect and Owner's Representative any errors, inconsistencies or omissions discovered. If the Contractor performs any construction activity which it knows or should have known involves a recognized error, inconsistency, or omission in the Contract Documents without such written notice to the Architect and Owner's Representative, the Contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the attributable costs for correction.

3.6.2 The Contractor shall take field measurements and verify field conditions and shall carefully compare such field measurements and conditions and other information known to the Contractor with the Contract Documents before commencing activities. Errors, inconsistencies, or omissions discovered shall be reported in writing to the Architect and Owner's Representative within twenty-four (24) hours. During the progress of work, Contractor shall verify all field measurements prior to fabrication of building components or equipment and proceed with the fabrication to meet field conditions. Contractor shall consult all Contract Documents to determine the exact location of all work and verify spatial relationships of all work. Any question concerning said location or spatial relationships shall be submitted to the Owner's Representative. Specific locations for equipment, pipelines, ductwork and other such items of work, where not dimensioned on plans, shall be determined in consultation with Owner's Representative and Architect. Contractor shall be responsible for the proper fitting of the Work in place.

3.6.3 The Contractor shall provide, at the proper time, such material as required for support of the Work. If openings or chases are required, whether shown on Drawings or not, the Contractor shall see they are properly constructed. If required openings or chases are omitted, the Contractor shall cut them at the Contractors own expense, but only as directed by the Architect, through the Owner Representative.

3.6.4 Should the Contract Documents fail to particularly describe materials or goods to be used, it shall be the duty of the Contractor to inquire of the Architect and the Owner's Representative what is to be used and to supply it at the Contractor's expense, or else thereafter replace it to the Owner's Representative's satisfaction. At a minimum, the Contractor shall provide the quality of materials as generally specified throughout the Contract Documents.

3.7 Cleaning and Removal

3.7.1 The Contractor shall keep the Work site and surrounding areas free from accumulation of waste materials, rubbish, debris, and dirt resulting from the Work and shall clean the Work site and surrounding areas as requested by the Architect and the Owner's Representative, including mowing of grass greater than 6 inches high. The Contractor shall be responsible for the cost of clean up and removal of debris from premises. The building and premises shall be kept clean, safe, in a workmanlike manner, and in compliance with OSHA standards and code at all times. At completion of the Work, the Contractor shall remove from and about the Work site tools, construction equipment, machinery, fencing, and surplus materials. Further, at the completion of the work, all dirt, stains, and smudges shall be removed from every part of the building, all glass in doors and windows shall be washed, and entire Work shall be left broom clean in a finished state ready for occupancy. The Contractor shall advise his Subcontractors of any tier of this provision, and the Contractor shall be fully responsible for leaving the premises in a finished state ready for use to the satisfaction of the Owner's Representative. If the Contractor fails to comply with the provisions of this paragraph, the Owner may do so, and the cost thereof shall be charged to the Contractor.

3.8 Cutting and Patching

3.8.1 The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly.

3.8.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter

such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate contractor the Contractor's consent to cutting or otherwise altering the Work.

3.8.3 If the Work involves renovation and/or alteration of existing improvements, Contractor acknowledges that cutting and patching of the Work is essential for the Work to be successfully completed. Contractor shall perform any cutting, altering, patching, and/or fitting of the Work necessary for the Work and the existing improvements to be fully integrated and to present the visual appearance of an entire, completed, and unified project. In performing any Work which requires cutting or patching, Contractor shall use its best efforts to protect and preserve the visual appearance and aesthetics of the Work to the reasonable satisfaction of both the Owner's Representative and Architect.

3.9 Indemnification

3.9.1 To the fullest extent permitted by law, the Contractor shall defend, indemnify, and hold harmless the Owner, the Architect, Architect's consultants, and the agents, employees, representatives, insurers and re-insurers of any of the foregoing (hereafter collectively referred to as the "Indemnitees") from and against claims, damages (including loss of use of the Work itself), punitive damages, penalties and civil fines unless expressly prohibited by law, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from performance of the Work to the extent caused in whole or in part by negligent acts or omissions or other fault of Contractor, a Subcontractor of any tier, or anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by the negligent acts or omissions or other fault of a party indemnified hereunder. The Contractor's obligations hereunder are in addition to and shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that the Owner may possess. If one or more of the Indemnitees demand performance by the Contractor of obligations under this paragraph or other provisions of the Contract Documents and if Contractor refuses to assume or perform, or delays in assuming or performing Contractor's obligations, Contractor shall pay each Indemnitee who has made such demand its respective attorneys' fees, costs, and other expenses incurred in enforcing this provision. The defense and indemnity required herein shall be a binding obligation upon Contractor whether or not an Indemnitee has made such demand. Even if a defense is successful to a claim or demand for which Contractor is obligated to indemnify the Indemnitees from under this Paragraph, Contractor shall remain liable for all costs of defense.

3.9.2 The indemnity obligations of Contractor under this Section 3.9 shall survive termination of this Contract or final payment thereunder. In the event of any claim or demand made against any party which is entitled to be indemnified hereunder, the Owner may in its sole discretion reserve, return or apply any monies due or to become due the Contractor under the Contract for the purpose of resolving such claims; provided, however, that the Owner may release such funds if the Contractor provides the Owner with reasonable assurance of protection of the Owner's interests. The Owner shall in its sole discretion determine if such assurances are reasonable. Owner reserves the right to control the defense and settlement of any claim, action or proceeding which Contractor has an obligation to indemnify the Indemnitees against under Paragraph 3.9.1.

3.9.3 In claims against any person or entity indemnified under this Section 3.9 by an employee of the Contractor, a Subcontractor of any tier, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under this Section 3.9 shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or a Subcontractor of any tier under workers' or workmen's compensation acts, disability benefit acts or other employee benefit acts.

3.9.4 The obligations of the Contractor under Paragraph 3.9.1 shall not extend to the liability of the Architect, his agents or employees, arising out of the preparation and approval of maps, drawings, opinions, reports, surveys, Change Orders, designs, or Specifications.

3.10 Patents

3.10.1 The Contractor shall hold and save harmless the Owner and its officers, agents, servants, and employees from liability of any nature or kind, including cost and expense, for, or on account of, any patented or otherwise protected invention, process, article, or appliance manufactured or used in the performance of the Contract, including its use by the Owner, unless otherwise specifically stipulated in the Contract Documents.

3.10.2 If the Contractor uses any design, device, or material covered by letters patent or copyright, he shall provide for such use by suitable agreement with the Owner of such patented or copyrighted design, device, or material. It is mutually agreed and understood, without exception, that the Contract Sum include, and the Contractor shall pay all royalties, license fees or costs arising from the use of such design, device, or material in any way involved in the Work. The Contractor and/or sureties shall indemnify and save harmless the Owner from any and all claims for infringement by reason of the use of such patented or copyrighted design, device, or material or any trademark or copyright in connection with Work agreed to be performed under this Contract and shall indemnify the Owner for any cost, expense, or damage it may be obligated to pay by reason of

such infringement at any time during the prosecution of the Work or after completion of the Work.

3.11 Delegated Design

3.11.1 If the Contract Documents specify the Contractor is responsible for the design of any work as part of the project, then the Contractor shall procure all design services and certifications necessary to complete the Work as specified, from a design professional licensed in the State of Missouri. The signature and seal of that design professional shall appear on all drawings, calculations, specifications, certifications, shop drawings, and other submittals related to the Work. The design professional shall maintain insurance as required per Article 11.

3.12 Materials, Labor, and Workmanship

3.12.1 Materials and equipment incorporated into the Work shall strictly conform to the Contract Documents and representations and approved Samples provided by Contractor and shall be of the most suitable grade of their respective kinds for their respective uses and shall be fit and sufficient for the purpose intended, merchantable, of good new material and workmanship, and free from defect. Workmanship shall be in accordance with the highest standard in the industry and free from defect in strict accordance with the Contract Documents.

3.12.2 Materials and fixtures shall be new and of latest design unless otherwise specified and shall provide the most efficient operating and maintenance costs to the Owner. All Work shall be performed by competent workers and shall be of best quality.

3.12.3 The Contractor shall carefully examine the Contract Documents and shall be responsible for the proper fitting of his material, equipment, and apparatus into the building.

3.12.4 The Contractor shall base his bid only on the Contract Documents.

3.12.5 Materials and workmanship shall be subject to inspection, examination, and testing by the Architect and the Owner's Representative at any and all times during manufacture, installation, and construction of any of them, at places where such manufacture, installation, or construction is performed.

3.12.6 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Contract. The Contractor shall not permit employment of unfit persons or persons not skilled in tasks assigned to them.

3.12.7 Unless otherwise specifically noted, the Contractor shall provide and pay for supervision, labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for the proper execution and completion of the Work.

3.12.8 Substitutions

3.12.8.1 A substitution is a Contractor proposal of an alternate product or method in lieu of what has been specified or shown in the Contract Documents, which is not an "or equal" as set forth in Section 3.12.1.

3.12.8.2 Contractor may make a proposal to the Architect and the Owner's Representative to use substitute products or methods as set forth herein, but the Architect's and the Owner's Representative's decision concerning acceptance of a substitute shall be final. The Contractor must do so in writing and setting forth the following:

.1 Full explanation of the proposed substitution and submittal of all supporting data including technical information, catalog cuts, warranties, test results, installation instructions, operating procedures, and other like information necessary for a complete evaluation of the substitution.

.2 Reasons the substitution is advantageous and necessary, including the benefits to the Owner and the Work in the event the substitution is acceptable.

.3 The adjustment, if any, in the Contract Sum, in the event the substitution is acceptable.

.4 The adjustment, if any, in the time of completion of the Contract and the construction schedule in the event the substitution is acceptable.

.5 An affidavit stating that (a) the proposed substitution conforms to and meets all of the Contract Document requirements and is code compliant, except as specifically disclosed and set forth in the affidavit and (b) the Contractor accepts the warranty and correction obligations in connection with the proposed substitution as if originally specified by the Architect. Proposals for substitutions shall be submitted to the Architect and Owner's Representative in sufficient time to allow the Architect and Owner's Representative no less than ten (10) working days for review. No substitution will be considered or allowed without the Contractor's submittal of complete substantiating data and information as stated herein.

3.12.8.3 Substitutions may be rejected without explanation at the Owner's sole discretion and will be considered only under one or more of the following conditions:

.1 Required for compliance with interpretation of code requirements or insurance regulations then existing;

.2 Unavailability of specified products, through no fault of the Contractor;

.3 Material delivered fails to comply with the Contract Documents;

.4 Subsequent information discloses inability of specified products to perform properly or to fit in designated space;

.5 Manufacturer/fabricator refuses to certify or guarantee performance of specified product as required; or

.6 When in the judgment of the Owner or the Architect, a substitution would be substantially to the Owner's best interests, in terms of cost, time, or other considerations.

3.12.8.4 Whether or not any proposed substitution is accepted by the Owner or the Architect, the Contractor shall reimburse the Owner for any fees charged by the Architect or other consultants for evaluating each proposed substitution.

3.13 Approved Equal

3.13.1 Whenever in the Contract Documents any article, appliance, device, or material is designated by the name of a manufacturer, vendor, or by any proprietary or trade name, the words "or approved equal," shall automatically follow and shall be implied unless specifically indicated otherwise. The standard products of manufacturers other than those specified will be accepted when, prior to the ordering or use thereof, it is proven to the satisfaction of the Owner's Representative and the Architect they are equal in design, appearance, spare parts availability, strength, durability, usefulness, serviceability, operation cost, maintenance cost, and convenience for the purpose intended. Any general listings of approved manufacturers in any Contract Document shall be for informational purposes only and it shall be the Contractor's sole responsibility to ensure that any proposed "or equal" complies with the requirements of the Contract Documents and is code compliant.

3.13.2 The Contractor shall submit to Architect and Owner's Representative a written and full description of the proposed "or equal" including all supporting data, including technical information, catalog cuts, warranties, test results, installation instructions, operating procedures, and similar information demonstrating that the proposed "or equal" strictly complies with the Contract Documents. The Architect or Owner's Representative shall take appropriate action with respect to the submission of a proposed "or equal" item. If Contractor fails to submit proposed "or equals" as set forth herein, it shall waive any right to supply such items. The Contract Sum and Contract Time shall not be adjusted as a result of any failure by Contractor to submit proposed "or equals" as provided for herein. All documents submitted in connection with preparing an "or equal" shall be clearly and obviously marked as a proposed "or equal" submission.

3.13.3 No approvals or action taken by the Architect or Owner's Representative shall relieve Contractor from its obligation to ensure that an "or equal" article, appliance, devise, or material strictly complies with the requirements of the Contract Documents. Contractor shall not propose "or equal" items in connection with Shop Drawings or other Submittals, and Contractor acknowledges and agrees that no approvals or action taken by the Architect or Owner's Representative with respect to Shop Drawings or other Submittals shall constitute approval of any "or equal" item or relieve Contractor from its sole and exclusive responsibility. Any changes required in the details and dimensions indicated in the Contract Documents for the incorporation or installation of any "or equal" item supplied by the Contractor shall be properly made and approved by the Architect at the expense of the Contractor. No 'or equal' items will be permitted for components of or extensions to existing systems when, in the opinion of the Architect, the named manufacturer must be provided in order to ensure compatibility with the existing systems, including, but not limited to, mechanical systems, electrical systems, fire alarms, smoke detectors, etc. No action will be taken by the Architect with respect to proposed "or equal" items prior to receipt of bids, unless otherwise noted in the Special Conditions.

3.14 Shop Drawings, Product Data, Samples, and Coordination Drawings/BIM Models

3.14.1 Shop Drawings are drawings, diagrams, schedules, and other data specifically prepared for the Work by the Contractor or a Subcontractor, sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

3.14.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

3.14.3 Samples are physical samples which illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.

3.14.4 Coordination Drawings are drawings for the integration of the Work, including work first shown in detail on shop drawings or product data. Coordination drawings show sequencing and relationship of separate units of work which must interface in a restricted manner to fit in the space provided, or function as indicated. Coordination Drawings are the responsibility of the contractor and are submitted for informational purposes. The Special Conditions will state whether coordination drawings are required. BIM models may be used for coordination in lieu of coordination drawings at the contractor's discretion, unless required in the Special Conditions. The final coordination drawings/BIM Model will not change the contract documents, unless approved by a fully executed change order describing the specific modifications that are being made to the contract documents.

3.14.5 Shop Drawings, Coordination Drawings/BIM Models, Product Data, Samples and similar submittals (collectively referred to as "Submittals") are not Contract Documents. The purpose of their submittal is to demonstrate for those portions of the Work for which submittals are

required the way the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.

3.14.6 The Contractor shall schedule submittal of Shop Drawings and Product Data to the Architect so that no delays will result in delivery of materials and equipment, advising the Architect of priority for checking of Shop Drawings and Product Data, but a minimum of two weeks shall be provided for this purpose. Because time is of the essence in this contract, unless noted otherwise in the Special Conditions or Technical Specifications, all submittals, shop drawings and samples must be submitted as required to maintain the contractor's plan for proceeding but must be submitted within 90 days of the Notice to Proceed. If Contractor believes that this milestone is unreasonable for any submittal, Contractor shall request an extension of this milestone, within 60 days of Notice to Proceed, for each submittal that cannot meet the milestone. The request shall contain a reasonable explanation as to why the 90-day milestone is unrealistic, and shall specify a date on which the submittal will be provided, for approval by the Owner's Representative. Failure of the Contractor to comply with this section may result in delays in the submittal approval process and/or charges for expediting approval, both of which will be the responsibility of the Contractor.

3.14.7 The Contractor, at its own expense, shall submit Samples required by the Contract Documents with reasonable promptness as to cause no delay in the Work or the activities of separate contractors and no later than twenty (20) days before materials are required to be ordered for scheduled delivery to the Work site. Samples shall be labeled to designate material or products represented, grade, place of origin, name of producer, name of Contractor and the name and number of the Owner's project. Quantities of Samples shall be twice the number required for testing so that Architect can return one set of the Samples. Materials delivered before receipt of Architect's approval may be rejected by Architect and in such event, Contractor shall immediately remove all such materials from the Work site. When requested by Architect or Owner's Representative, samples of finished masonry and field applied paints and finishes shall be located as directed and shall include sample panels built at the site of approximately twenty (20) square feet each.

3.14.8 The Contractor shall perform no portion of the Work requiring submittal and review of Shop Drawings, Product Data, Samples, or similar submittals until the respective submittal has been approved by the Architect. Such Work shall be in accordance with approved submittals.

3.14.9 By approving and submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents such Submittals strictly comply with the requirements of the Contract Documents and that the Contractor has determined and verified field measurements and field construction criteria related thereto, that materials are fit for their intended use and that the fabrication, shipping, handling, storage, assembly and installation of all materials, systems and equipment are in accordance with best practices in the industry and are in strict compliance with any applicable requirements of the Contract Documents. Contractor shall also coordinate each Submittal with other Submittals.

3.14.10 Contractor shall be responsible for the correctness and accuracy of the dimensions, measurements and other information contained in the Submittals.

3.14.11 Each Submittal will bear a stamp or specific indication that the Submittal complies with the Contract Documents and Contractor has satisfied its obligations under the Contract Documents with respect to Contractor's review and approval of that Submittal. Each Submittal shall bear the signature of the representative of Contractor who approved the Submittal, together with the Contractor's name, Owner's name, number of the Project, and the item name and specification section number.

3.14.12 The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data, Samples, or similar submittals. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals by the Architect's approval thereof. Specifically, but not by way of limitation, Contractor acknowledges that Architect's approval of Shop Drawings shall not relieve Contractor for responsibility for errors and omissions in the Shop Drawings since Contractor is responsible for the correctness of dimensions, details and the design of adequate connections and details contained in the Shop Drawings.

3.14.13 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples or similar submittals, to revisions other than those requested by the Architect on previous Submittals.

3.14.14 The Contractor represents and warrants that all Shop Drawings shall be prepared by persons and entities possessing expertise and experience in the trade for which the Shop Drawing is prepared and, if required by the Architect or applicable Laws, by a licensed engineer or other design professional.

3.15 Record Drawings

3.15.1 The Contractor shall maintain a set of Record Drawings on site in good condition and shall use colored pencils to mark up said set with "record information" in a legible manner to show: (1) bidding addendums, (2) executed change orders, (3)deviations from the Drawings made during construction; (4) details in the Work not previously shown; (5) changes to existing conditions or existing conditions found to differ from those shown on any existing drawings; (6) the actual installed position of equipment, piping, conduits, light switches, electric fixtures, circuiting, ducts, dampers, access

panels, control valves, drains, openings, and stub-outs; and (7) such other information as either Owner or Architect may reasonably request. The prints for Record Drawing use will be a set of "blue line" prints provided by Architect to Contractor at the start of construction. Upon Substantial Completion of the Work, Contractor shall deliver all Record Drawings to Owner and Architect for approval. If not approved, Contractor shall make the revisions requested by Architect or Owner's Representative. Final payment and any retainage shall not be due and owing to Contractor until the final Record Drawings marked by Contractor as required above are delivered to Owner.

3.16 Operating Instructions and Service Manuals

3.16.1 The Contractor shall submit four (4) volumes of operating instructions and service manuals to the Architect before completing 50% of the adjusted contract amount. Payments beyond 50% of the adjusted contract amount may be withheld until all operating instructions and service manuals are received. The operating instructions and service manuals shall contain:

.1 Start-up and Shutdown Procedures: Provide a step-by-step write up of all major equipment. When manufacturer's printed start-up, trouble shooting and shut-down procedures are available, they may be incorporated into the operating manual for reference.

.2 Operating Instructions: Written operating instructions shall be included for the efficient and safe operation of all equipment.

.3 Equipment List: List of all major equipment as installed shall include model number, capacities, flow rate, and name-plate data.

.4 Service Instructions: The Contractor shall be required to provide the following information for all pieces of equipment.

(a) Recommended spare parts including catalog number and name of local suppliers or factory representative.

(b) Belt sizes, types, and lengths.

(c) Wiring diagrams.

.5 Manufacturer's Certificate of Warranty: Manufacturer's certificates of warranty shall be obtained for all major equipment. Warranty shall be obtained for at least one year from the date of Substantial Completion. Where longer period is required by the Contract Documents, the longer period shall govern.

.6 Parts catalogs: For each piece of equipment furnished, a parts catalog or similar document shall be provided which identifies the components by number for replacement ordering.

3.16.2 Submission

.1 Manuals shall be bound into volumes of standard 8 1/2" x 11" hard binders. Large drawings too bulky to be folded into 8 1/2" x 11" shall be separately bound or folded and in brown envelopes, cross-referenced and indexed with the manuals.

.2 The manuals shall identify the Owner's project name, project number, and include the name and address of the Contractor and major Subcontractors of any tier who were involved with the activity described in that particular manual.

3.17 Taxes

3.17.1 The Contractor shall pay all applicable sales, consumer, use, and similar taxes for the Work which are legally enacted when the bids are received, whether or not yet effective or scheduled to go into effect. However, certain purchases by the Contractor of materials incorporated in or consumed in the Work are exempt from certain sales tax pursuant to RSMo § 144.062. The Contractor shall be issued a Project Tax Exemption Certificate for this Work to obtain the benefits of RSMo § 144.062.

3.17.2 The Contractor shall furnish this certificate to all subcontractors, and any person or entity purchasing materials for the Work shall present such certificate to all material suppliers as authorization to purchase, on behalf of the Owner, all tangible personal property and materials to be incorporated into or consumed in the Work and no other on a tax-exempt basis. Such suppliers shall provide to the purchasing party invoices bearing the name of the exempt entity and the project identification number. Nothing in this section shall be deemed to exempt from any sales or similar tax the purchase of any construction machinery, equipment or tools used in construction, repairing or remodeling facilities for the Owner. All invoices for all personal property and materials purchased under a Project Tax Exemption Certificate shall be retained by the Contractor for a period of five years and shall be subject to audit by the Director of Revenue.

3.17.3 Any excess resalable tangible personal property or materials which were purchased for the project under this Project Tax Exemption Certificate but which were not incorporated into or consumed in the Work shall either be returned to the supplier for credit or the appropriate sales or use tax on such excess property or materials shall be reported on a return and paid by such purchasing party not later than the due date of the purchasing party's Missouri sales or use tax return following the month in which it was determined that the materials were not used in the Work.

3.17.4 If it is determined that sales tax is owed by the Contractor on property and materials due to the failure of the Owner to revise the certificate expiration date to cover the applicable date of purchase, Owner shall be liable for the tax owed.

3.17.5 The Owner shall not be responsible for any tax liability due to Contractor's neglect to make timely orders, payments, etc. or Contractor's misuse of the Project Tax Exemption Certificate. Contractor represents that the Project Tax Exemption Certificate shall be used in accordance with RSMo § 144.062 and the terms of the Project Tax Exemption

Certificate. Contractor shall indemnify the Owner for any loss or expense, including but not limited to, reasonable attorneys' fees, arising out of Contractor's use of the Project Tax Exemption Certificate.

3.18 Contractor's Construction Schedules

3.18.1 The Contractor, within fifteen (15) days after the issuance of the Notice to Proceed, shall prepare and submit for the Owner's and Architect's information Contractor's construction schedule for the Work and shall set forth interim dates for completion of various components of the Work and Work Milestone Dates as defined herein. The schedule shall not exceed time limits current under the Contract Documents, shall be revised on a monthly basis or as requested by the Owner's Representative as required by the conditions of the Work, and shall provide for expeditious and practicable execution of the Work. The Contractor shall conform to the most recent schedule.

3.18.2 The construction schedule shall be in a detailed format satisfactory to the Owner's Representative and the Architect and in accordance with the detailed schedule requirements set forth in this document and the Special Conditions. If the Owner's Representative or Architect has a reasonable objection to the schedule submitted by Contractor, the construction schedule shall be promptly revised by the Contractor. The Contractor shall monitor the progress of the Work for conformance with the requirements of the construction schedule and shall promptly advise the Owner of any delays or potential delays.

3.18.3 As time is of the essence to this contract, the University expects that the Contractor will take all necessary steps to ensure that the project construction schedule shall be prepared in accordance with the specific requirements of the Special Conditions to this contract. At a minimum, contractor shall comply with the following:

.1 The schedule shall be prepared using Primavera P3, Oracle P6, Microsoft Project or other software acceptable to the Owner's Representative.

.2 The schedule shall be prepared and maintained in CPM format, in accordance with Construction CPM Scheduling, published by the Associated General Contractors of American (AGC).

.3 Prior to submittal to the Owner's Representative for review, Contractor shall obtain full buy-in to the schedule from all major subcontractors, in writing if so, requested by Owner's Representative.

.4 Schedule shall be updated, in accordance with Construction CPM Scheduling, published by the AGC, on a monthly basis at minimum, prior to, and submitted with, the monthly pay application or as requested by the Owner's Representative.

.5 Along with the update the Contractor shall submit a narrative report addressing all changes, delays and impacts, including weather to the schedule during the last month, and explain how the end date has been impacted by same.

.6 The submission of the updated schedule certifies that all delays and impacts that have occurred on or to the project during the previous month have been factored into the update and are fully integrated into the schedule and the projected completion date.

Failure to comply with any of these requirements will be considered a material breach of this contract. See Special Conditions for detailed scheduling requirements.

3.18. 4 In the event the Owner's Representative or Architect determines that the performance of the Work, as of a Milestone Date, has not progressed or reached the level of completion required by the Contract Documents, the Owner shall have the right to order the Contractor to take corrective measures necessary to expedite the progress of construction, including, without limitation, (1) working additional shifts or overtime, (2) supplying additional manpower, equipment, facilities, (3) expediting delivery of materials, and (4) other similar measures (hereinafter referred to collectively as Extraordinary Measures). Such Extraordinary Measures shall continue until the progress of the Work complies with the stage of completion required by the Contract Documents. The Owner's right to require Extraordinary Measures is solely for the purpose of ensuring the Contractor's compliance with the construction schedule. The Contractor shall not be entitled to an adjustment in the Contract Sum concerning Extraordinary Measures required by the Owner under or pursuant to this Paragraph 3.17.3. The Owner may exercise the rights furnished the Owner under or pursuant to this Paragraph 3.17.3 as frequently as the Owner deems necessary to ensure that the Contractor's performance of the Work will comply with any Milestone Date or completion date set forth in the Contract Documents.

ARTICLE 4
ADMINISTRATION OF THE CONTRACT

4.1 Rights of the Owner

4.1.1 The Owner's Representative will administer the Construction Contract. The Architect will assist the Owner's Representative with the administration of the Contract as indicated in these Contract Documents.

4.1.2 If, in the judgment of the Owner's Representative, it becomes necessary to accelerate the work, the Contractor, when directed by the Owner's Representative in writing, shall cease work at any point and transfer its workers to such point or points and execute such portions of the work as may be required to enable others to hasten and properly engage and carry out the work, all as directed by the Owner's Representative. The additional cost of accelerating the work, if any, will be borne by the Owner, unless the Contractor's work progress is behind schedule as shown on the most recent progress schedule.

4.1.3 If the Contractor refuses, for any reason, to proceed with what the Owner believes to be contract work, the Owner may issue a Construction Directive, directing the Contractor to proceed. Contractor shall be obligated to promptly proceed with this work. If Contractor feels that it is entitled to additional compensation for this work, it may file a claim for additional compensation and/or time, in accordance with 4.4 of this Document.

4.1.4 The Owner's Representative, may, by written notice, require a Contractor to remove from involvement with the Work, any of Contractor's personnel or the personnel of its Subcontractors of any tier whom the Owner's Representative may deem abusive, incompetent, careless, or a hindrance to proper and timely execution of the Work. The Contractor shall comply with such notice promptly, but without detriment to the Work or its progress.

4.1.5 The Owner's Representative will schedule Work status meetings that shall be attended by representatives of the Contractor and appropriate Subcontractors of any tier. Material suppliers shall attend status meetings if required by the Owner's Representative. These meetings shall include preconstruction meetings.

4.1.6 The Owner does not allow smoking on university property.

4.2 Rights of the Architect

4.2.1 The Architect will interpret requirements of the Contract Documents with respect to the quality, quantity, and other technical requirements of the Work itself within a reasonable time after written request of the Contractor. Contractor shall provide Owner's Representative a copy of such written request.

4.3 Review of the Work

4.3.1 The Architect, the Owner's Representative, and the Owner's Authorized Agent shall, at all times, have access to the Work; and the Contractor shall provide proper and safe facilities for such access.

4.3.2 The Owner's Representative shall have authority to reject Work that does not strictly comply with the requirements of the Contract Documents. Whenever the Owner's Representative considers it necessary or advisable for implementation of the intent of the Contract Documents, Owner's Representative shall have the authority to require additional inspection or testing of the Work, whether or not such Work is fabricated, installed, or completed.

4.3.3 The fact that the Architect or the Owner's Representative observed, or failed to observe, faulty Work, or Work done which is not in accordance with the Contract Documents, regardless of whether or not the Owner has released final payment, shall not relieve the Contractor from responsibility for all damages and additional costs of the Owner as a result of defective or faulty Work.

4.4 Claims

4.4.1 A Claim is a demand or assertion by Contractor seeking, as a matter of right, adjustment or interpretation of Contract terms, payment of money, extension of time or any other relief with respect to the terms of the Contract. The term "Claim(s)" also includes demands and assertions of Contractor arising out of or relating to the Contract Documents, including Claims based upon breach of contract, mistake, misrepresentation, or other cause for Contract Modification or recision. Claims must be made by written notice. Contractor shall have the responsibility to substantiate Claims.

4.4.2 Claims by Contractor must be made promptly, and no later than within fourteen (14) days after occurrence of the event giving rise to such Claim. Claims must be made by written notice. Such notice shall include a detailed statement setting forth all reasons for the Claim and the amount of additional money and additional time claimed by Contractor. The notice of Claims shall also strictly comply with all other provisions of the Contract Documents. Contractor shall not be entitled to rely upon any grounds or basis for additional money on additional time not specifically set forth in the notice of Claim. All Claims not made in the manner provided herein shall be deemed waived and of no effect. Contractor shall furnish the Owner and Architect such timely written notice of any Claim provided for herein, including, without limitation, those in connection with alleged concealed or unknown conditions, and shall cooperate with the Owner and Architect in any effort to mitigate the alleged or potential damages, delay or other adverse consequences arising out of the condition which is the cause of such a Claim.

4.4.3 Pending final resolution of a Claim, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments that are not in dispute in accordance with the Contract Documents.

4.5 Claims for Concealed or Unknown Conditions

4.5.1 If conditions are encountered at the site which are (1) subsurface or otherwise concealed physical conditions which differ materially from those indicated in the Contract Documents, or (2) unknown physical conditions of an unusual nature, which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, then notice by the Contractor shall be given to the Owner's Representative promptly before conditions are disturbed, and in no event later than three (3) days after first observance of the conditions. The Owner's Representative will promptly investigate such conditions. If such conditions differ materially, as provided for above and cause an increase or decrease in the Contractor's cost, or time, required for performance of the Work, an equitable adjustment in the Contract sum or Contract Time, or both, shall be made, subject to the provisions and restrictions set for herein. If the Owner's Representative determines that the

conditions at the site are not materially different from those indicated in the Contract Documents, and that no change in the terms of the Contract is justified, the Owner's Representative will so notify the Contractor in writing. If the Contractor disputes the finding of the Owner's Representative that no change in the terms of the Contract terms is justified, Contractor shall proceed with the Work, taking whatever steps are necessary to overcome or correct such conditions so that Contractor can proceed in a timely manner. The Contractor may have the right to file a Claim in accordance with the Contract Documents.

4.5.2 It is expressly agreed that no adjustment in the Contract Time or Contract Sum shall be permitted, however, in connection with a concealed or unknown condition which does not differ materially from those conditions disclosed or which reasonably should have been disclosed by the Contractor's (1) prior inspections, tests, reviews and preconstruction investigations for the Project, or (2) inspections, tests, reviews and preconstruction inspections which the Contractor had the opportunity to make or should have performed in connection with the Project.

4.6 Claim for Additional Cost

4.6.1 If the Contractor makes a Claim for an increase in the Contract Sum, written notice as provided herein shall be given before proceeding to execute the Work. In addition to all other requirements for notice of a Claim, said notice shall detail and itemize the amount of all Claims and shall contain sufficient data to permit evaluation of same by Owner.

4.7 Claims for Additional Time

4.7.1 If the Contractor makes a Claim for an increase in the Contract Time, written notice as provided herein shall be given. In addition to other requirements for notice of a Claim, Contractor shall include an estimate of the probable effect of delay upon the progress of the Work, utilizing a CPM Time Impact Schedule Analysis, (TIA) as defined in the AGC Scheduling Manual. In the case of a continuing delay, only one Claim is necessary.

.1 Time extensions will be considered for excusable delays only. That is, delays that are beyond the control and/or contractual responsibility of the Contractor.

4.7.2 If weather days are the basis for a Claim for additional time, such Claim shall be documented by the Contractor by data acceptable to the Owner's Representative substantiating that weather conditions for the period of time in question, had an adverse effect on the critical path of the scheduled construction. Weather days shall be defined as days on which critical path work cannot proceed due to weather conditions (including but not limited to rain, snow, etc.), in excess of the number of days shown on the Anticipated Weather Day schedule in the Special Conditions. To be considered a weather day, at least four working hours must be lost due to the weather conditions on a critical path scope item for that day.-Weather days and Anticipated weather days listed in the Special Conditions shall only apply to Monday through Friday. A weather day claim cannot be made for Saturdays, Sundays, New Year's Day, Martin Luther King Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the day after Thanksgiving Day and Christmas Day, unless that specific day was approved in writing for work by the Owner's Representative.

.1 The Contractor must have fulfilled its contract obligations with respect to temporary facilities and protection of its work, and worker protection for hot and cold weather per OSHA guidelines.

.2 If the contract obligations have been satisfied, the Owner will review requests for non-compensable time extensions for critical path activities as follows:

.2.1 If the Contractor cannot work on a critical path activity due to adverse weather, after implementing all reasonable temporary weather protection, the Contractor will so notify the Owner's Representative. Each week, the Contractor will notify the Owner's Representative of the number of adverse weather days that it believes it has experienced in the previous week. As provided in the contract, until such time as the weather days acknowledged by the Owner's Representative exceed the number of days of adverse weather contemplated in the Special Conditions, no request for extension of the contract completion time will be considered.

.2.2 If the Contractor has accumulated in excess of the number of adverse weather days contemplated in the Special Conditions due to the stoppage of work on critical path activities due to adverse weather, the Owner will consider a time extension request from the Contractor that is submitted in accordance with the contract requirements. The Owner will provide a change order extending the time for contract completion or direct an acceleration of the work in accordance with the contract terms and conditions to recover the time lost due to adverse weather in excess of the number of adverse weather working days contemplated in the Special Conditions.

4.7.3 A Force Majeure event or circumstance shall not be the basis of a claim by the Contractor seeking an adjustment in the Contract amount for costs or expenses of any type. With the exception of weather delays which are administered under this Article 4, and not withstanding other requirements of the Contract, all Force Majeure events resulting in a delay

to the critical path of the project shall be administered as provided in Article 8.

4.7.4 The Owner will consider and evaluate requests for time extensions due to changes or other events beyond the control of the Contractor on a monthly basis only, with the submission of the Contractor's updated schedule, in conjunction with the monthly application for payment.

4.8 Resolution of Claims and Disputes

4.8.1 The Owner's Representative will review Claims and take one or more of the following preliminary actions within ten days of receipt of a Claim: (1) request additional supporting data from the Contractor, (2) reject the Claim in whole or in part, (3) approve the Claim, or (4) suggest a compromise.

4.8.2 If a Claim has not been resolved, the Contractor shall, within ten days after the Owner's Representative's preliminary response, take one or more of the following actions: (1) submit additional supporting data requested, (2) modify the initial Claim, or (3) notify the Owner's Representative that the initial Claim stands.

4.8.3 If a Claim has not been resolved after consideration of the foregoing and of further information presented by the Contractor, the Contractor has the right to seek administrative review as set forth in Section 4.9. However, Owner's Representative's decisions on matters relating to aesthetics will be final.

4.9 Administrative Review

4.9.1 Claims not resolved pursuant to the procedures set forth in the Contract Documents except with respect to Owner's Representative's decision on matters relating to aesthetic effect, and except for claims which have been waived by the making or acceptance of final payment, or the Contractor's acceptance of payments in full for changes in work may be submitted to administrative review as provided in this section. All requests for administrative review shall be made in writing.

4.9.2 Upon written request from the Contractor, the Owner's Review Administrator authorized by the Campus Contracting Officer will convene a review meeting between the Contractor and Owner's Representative's within fifteen (15) days of receipt of such written request. The Contractor and Owner's Representative will be allowed to present written documentation with respect to the claim(s) before or during the meeting. The Contractor and Owner's Representative will be allowed to present the testimony of any knowledgeable person regarding the claim at the review meeting. The Owner's Review Administrator will issue a written summary of the review meeting and decision to resolve the Claim within fifteen (15) days. If the Contractor is in agreement with the decision the Contractor shall notify the Owner's Review Administrator in writing within five (5) days, and appropriate documentation will be signed by the parties to resolve the Claim.

4.9.3 If the Contractor is not in agreement with the proposal of the Owner's Review Administrator as to the resolution of the claim, the Contractor may file a written appeal with the UM System Contracting Officer, [in care of the Director of Facilities Planning and Development, University of Missouri, 109 Old Alumni Centers, University of Missouri, Columbia, Missouri 65211] within fifteen (15) days after receipt of the Owner's Review Administrator's proposal. The UM System Contracting Officer will call a meeting of the Contractor, the Owner's Representative, and the Owner's Review Administrator by written notice, within thirty (30) days after receipt of the Contractor's written appeal. The Owner's Review Administrator shall provide the UM System Contracting Officer with a copy of the written decision and summary of the review meeting, the Contractor's corrections or comments regarding the summary of the review meeting, and any written documentation presented by the Contractor and the Owner's Representative at the initial review meeting. The parties may present further documentation and/or present the testimony of any knowledgeable person regarding the claim at the meeting called by the UM System Contracting Officer.

4.9.4 The UM System Contracting Officer will issue a written decision to resolve the claim within fifteen (15) days after the meeting. If the Contractor is in agreement with the UM System Contracting Officer's proposal, the Contractor shall notify the UM System Contracting Officer in writing within five (5) days, and the Contractor and the Owner shall sign appropriate documents. The issuance of the UM System Contracting Officer's written proposal shall conclude the administrative review process even if the Contractor is not in agreement. However, proposals and any opinions expressed in such proposals issued under this section will not be binding on the Contractor nor will the decisions or any opinions expressed be admissible in any legal actions arising from the Claim and will not be deemed to remove any right or remedy of the Contractor as may otherwise exist by virtue of Contract Documents or law. Contractor and Owner agree that the Missouri Circuit Court for the County where the Work is located shall have exclusive jurisdiction to determine all issues between them. Contractor agrees not to file any complaint, petition, lawsuit or legal proceeding against Owner except with such Missouri Circuit Court.

ARTICLE 5
SUBCONTRACTORS

5.1 Award of Subcontracts

5.1.1 Pursuant to Article 9, the Contractor shall furnish the Owner and the Architect, in writing, with the name, and trade for each Subcontractor and the names of all persons or entities proposed as manufacturers of products, materials and equipment identified in the Contract Documents and where applicable, the name of the installing contractor. The

Owner's Representative will reply to the Contractor in writing if the Owner has reasonable objection to any such proposed person or entity. The Contractor shall not contract with a proposed person or entity to whom the Owner has made reasonable and timely objection.

5.1.2 The Contractor may request to change a subcontractor. Any such request shall be made in writing to the Owner's Representative. The Contractor shall not change a Subcontractor, person, or entity previously disclosed if the Owner makes reasonable objection to such change.

5.1.3 The Contractor shall be responsible to the Owner for acts, defaults, and omissions of its Subcontractors of any tier.

5.2 Subcontractual Relations

5.2.1 By appropriate agreement, written where legally required for validity, the Contractor shall require each Subcontractor of any tier, to the extent of the Work to be performed by the Subcontractor of any tier, to be bound to the Contractor by terms of the Contract Documents and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these Documents, assumes toward the Owner and the Architect. Each subcontract agreement of any tier shall preserve and protect the rights of the Owner and the Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor of any tier so that subcontracting thereof will not prejudice such rights and shall allow to the Subcontractor of any tier, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with its sub-subcontractors. The Contractor shall make available to each proposed Subcontractor of any tier, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor of any tier shall be bound Subcontractors of any tier shall similarly make copies of applicable portions of such documents available to their respective proposed Subcontractors of any tier.

5.2.2 All agreements between the Contractor and a Subcontractor or supplier shall contain provisions whereby Subcontractor or supplier waives all rights against the Owner, contractor, Owner's representative, Architect and all other additional insureds for all losses and damages caused by, arising out of, or resulting from any of the perils covered by property or builders risk insurance coverage required of the Contractor in the Contract Documents. If Contractor fails to include said provisions in all subcontracts, Contractor shall indemnify, defend and hold all the above entities harmless in the event of any legal action by Subcontractor or supplier. If insureds on any such policies require separate waiver forms to be signed by any Subcontractors of any tier or suppliers, Contractor shall obtain the same.

5.3 Contingent Assignment of Subcontract

5.3.1 No assignment by the Contractor of any amount or any part of the Contract or of the funds to be received thereunder will be recognized unless such assignment has had the written approval of the Owner, and the surety has been given due notice of such assignment and has furnished written consent hereto. In addition to the usual recitals in assignment Contracts, the following language must be set forth: "it is agreed that the funds to be paid to the assignee under this assignment are subject to performance by the Contractor of the contract and to claims and to liens for services rendered or materials supplied for the performance of the Work called for in said contract in favor of all persons, firms or corporations rendering such services or supplying such materials.

ARTICLE 6
SEPARATE CONTRACTS AND COOPERATION

6.1 The Owner reserves the right to let other contracts in connection with the Work.

6.2 It shall be the duty of each Contractor to whom Work may be awarded, as well as all Subcontractors of any tier employed by them, to communicate immediately with each other in order to schedule Work, locate storage facilities, etc., in a manner that will permit all Contractors to work in harmony in order that Work may be completed in the manner and within the time specified in the Contract Documents.

6.3 No Contractor shall delay another Contractor by neglecting to perform his work at the proper time. Each Contractor shall be required to coordinate his work with other Contractors to afford others reasonable opportunity for execution of their work. Any costs caused by defective, non-compliant, or ill- timed work, including actual damages and liquidated damages for delay, if applicable, shall be borne by the Contractor responsible therefor.

6.4 Each Contractor shall be responsible for damage to Owner's or other Contractor's property done by him or persons in his employ, through his or their fault or negligence. If any Contractor shall cause damage to any other Contractor, the Contractor causing such damage shall upon notice of any claim, settle with such Contractor.

6.5 The Contractor shall not claim from the Owner money damages or extra compensation under this Contract when delayed in initiating or completing his performance hereunder, when the delay is caused by labor disputes, acts of God, or the failure of any other Contractor to complete his performance under any Contract with the Owner, where any such cause is beyond the Owner's reasonable control.

6.6 Progress schedule of the Contractor for the Work shall be submitted to other Contractors as necessary to permit coordinating their progress schedules.

6.7 If Contractors or Subcontractors of any tier refuse to cooperate with the instructions and reasonable requests of other contractors performing work for the Owner under separate contract, in the overall coordinating of the Work, the Owner's Representative may take such appropriate action and issue such instructions as in his judgement may be required to avoid unnecessary and unwarranted delay.

ARTICLE 7
CHANGES IN THE WORK

7.1 CHANGE ORDERS

7.1.1 A change order is a written instrument prepared by the Owner and signed by the Owner and Contractor formalizing their agreement on the following:

.1 a change in the Work

.2 the amount of an adjustment, if any, in the Contract amount

.3 an adjustment, if any, in the Contract time

7.1.2 The Owner may at any time, order additions, deletions, or revisions in the Work by a Change Order or a Construction Change Directive. Such Change Order or Construction Change Directive shall not invalidate the Contract and requires no notice to the surety. Upon receipt of any such document, or written authorization from the Owner's Representative directing the Contractor to proceed pending receipt of the document, Contractor shall promptly proceed with the Work involved in accordance with the terms set forth therein.

7.1.3 Until such time as the change order is formalized and signed by both the Owner and the Contractor it shall be considered a Change Order Request.

7.1.4 The amount of adjustment in the contract price for authorized Change Orders will be agreed upon before such Change Orders becomes effective and will be determined as follows:

.1 By a lump sum proposal from the Contractor and the Subcontractors of any tier, including overhead and profit.

.2 By a time and material basis with or without a specified maximum. The Contractor shall submit to the Owner's Representative itemized time and material sheets depicting labor, materials, equipment utilized in completing the Work on a daily basis for the Owner's Representative approval. If this pricing option is utilized, the Contractor may be required to submit weekly reports summarizing costs to date on time and material change orders not yet finalized.

.3 By unit prices contained in the Contractor's original bid and incorporated in the Construction Contract or subsequently agreed upon. Such unit prices contained in the Contractor's original proposal are understood to include the Contractor's overhead and profit. If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are so changed in a proposed Change Order that application of such unit prices to quantities of the Work proposed will cause substantial inequity to the Owner or to the Contractor, the applicable unit prices shall be equitably adjusted.

7.1.5 The Contractor shall submit all fully documented change order requests with corresponding back-up documentation within the time requested by the Owner but no later than fourteen (14) working days following 1.) the Owner's request for change order pricing in the case of a lump sum; or 2.) the completion of unit price or time and material work.

7.1.6 The Contractor shall submit change order requests in sufficient detail to allow evaluation by the Owner. Such requests shall be fully itemized by units of labor, material and equipment and overhead and profit. Such breakdowns shall be itemized as follows:

.1 Labor: The Contractor's proposal shall include breakdowns by labor, by trade, indicating number of hours and cost per hour for each Subcontractor as applicable. Such breakdowns shall only include employees in the direct employ of Contractor or Subcontractors in the performance of the Work. Such employees shall only include laborers at the site, mechanics, craftsmen and foremen. Payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor or Subcontractors. Any item or expense outside of these categories is not allowed. The expense of performing Work after regular working hours, on Saturdays, Sundays or legal holidays shall not be included in the above, unless approved in writing and in advance by Owner.

.2 Material, supplies, consumables and equipment to be incorporated into the Work at actual invoice cost to the Contractor or Subcontractors; breakdowns showing all material, installed equipment and consumables fully itemized with number of units installed and cost per unit extended. Any singular item or items in aggregate greater than one thousand dollars ($1,000) in cost shall be supported with supplier invoices at the request of the Owner's Representative. Normal hand tools are not compensable.

.3 Equipment: Breakdown for required equipment shall itemize (at a minimum) delivery / pick-up charge, hourly

rate and hours used. Operator hours and rate shall not be included in the equipment breakdown. Contractor must use the most cost-effective equipment available in the area and should not exceed the rates listed in the Rental Rate Blue Book for Construction Equipment (Blue Book). Contractor shall submit documentation for the Blue Book to support the rate being requested.

7.2 Construction Change Directive

7.2.1 A construction change directive is a written order prepared and signed by the Owner, issued with supporting documents prepared by the Architect (if applicable), directing a change in the Work prior to agreement on adjustment of the Contract amount or Contract time, or both. A Construction Change Directive shall be used in the absence of complete agreement between the Owner and Contractor on the terms of a change order. If the Construction Change Directive allows an adjustment of the contract amount or time, such adjustment amount shall be based on one of the following methods:

.1 A lump sum agreement, properly itemized and supported by substantiating documents of sufficient detail to allow evaluation.

.2 By unit prices contained in the Contractor's original proposal and incorporated in the Construction Contract or subsequently agreed upon.

.3 A method agreed to by both the Owner and the contractor with a mutually agreeable fee for overhead and profit.

.4 In the absence of an agreement between the Owner and the Contractor on the method of establishing an adjustment of the contract amount, the Owner, with the assistance of the architect, shall determine the adjustment amount on the basis of expenditures by the Contractor for labor, materials, equipment, and other costs consistent with other provisions of the Contract. The contractor shall keep and submit to the Owner an itemized accounting of all cost components, either expended or saved, while performing the Work covered under the Construction Change Directive.

7.2.2 Upon receipt of a Construction Change Directive, Contractor shall promptly proceed with the change in the Work involved and advise Owner of Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum, Contract Time, or both.

7.2.3 A Construction Change Directive signed by Contractor indicates the agreement of the Contractor therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

7.3 Overhead and Profit

7.3.1 Overhead and Profit on Change Orders shall be applied as follows:

.1 The overhead and profit charged by the Contractor and Subcontractors shall be considered to include, but not limited to, job site office and clerical expense, normal hand tools, incidental job supervision, field supervision, payroll costs and other compensation for project manager, officers, executives, principals, general managers, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, time-keepers, and other personnel employed whether at the site or in principal or a branch office for general superintendent and administration of the Work.

.2 The percentages for overhead and profit charged on Change Orders shall be negotiated and may vary according to the nature, extent, and complexity of the Work involved but in no case shall exceed the following:

15% To the Contractor or the Subcontractor of any tier for Work performed with their respective forces or materials purchased

5% To the Contractor on Work performed by other than his forces

5% To first tier Subcontractor on Work performed by his Subcontractor

.3 The Contractor will be allowed to add 2% for the cost of bonding and insurance to their cost of work. This 2% shall be allowed on the total cost of the added work, including overhead and profit.

.4 Not more than three mark-ups, not to exceed individual maximums shown above, shall be allowed regardless of the number of tier subcontractors. Overhead and profit shall be shown separately for each subcontractor of any tier and the Contractor.

.5 On proposals covering both increases and decreases in the amount of the Contract, the application of overhead and profit shall be on the net change in direct cost for the Contractor or Subcontractor of any tier performing the Work.

.6 The percentages for overhead and profit credit to the Owner on Change Orders that are strictly decreases in the quantity of work or materials shall be negotiated and may vary according to the nature, extent, and complexity of the Work involved, but shall not be less than the following:

Overhead and Profit

7.5% Credit to the Owner from the Contractor or Subcontractor of any tier for Work performed with their respective forces or materials purchased

2.5% Credit to the Owner from the Contractor on Work performed by other than his forces

2.5% Credit to the Owner from the first tier Subcontractor on Work performed by his Subcontractor of any tier

7.4 Extended General Conditions

7.4.1 The Contractor acknowledges that the percentage mark-up allowed on change orders for overhead and profit cover the Contractor's cost of administering and executing the Work, inclusive of change orders that increase the contract time. Contractor further acknowledges that no compensation beyond the specified mark-up percentages for extended overhead shall be due or payable as a result of an increase in the Contract Time.

7.4.2 The Owner may reimburse the Contractor for extended overhead if an extension of the Contract Time is granted by the Owner, in accordance with Article 4.7.1 and the Owner determines that the extension of the Contract Time creates an inequitable condition for the Contractor. If these conditions are determined by the Owner to exist, the Contractor may be reimbursed by unit prices contained in the Contractor's original bid and incorporated in the Construction Contract or by unit prices subsequently agreed upon.

7.4.3 If unit prices are subsequently agreed upon, the Contractor's compensation shall be limited as follows:

.1 For the portion of the direct payroll cost of the Contractor's project manager expended in completing the Work and the direct payroll cost of other onsite administrative staff not included in Article 7.3.1. Direct payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor;

.2 Cost of Contractor's temporary office, including temporary office utilities expense;

.3 Cost of temporary utilities required in the performance of the work;

.4 Profit not to exceed 5% of the total extended overhead direct costs;

7.4.4 All costs not falling into one of these categories and costs of the Contractors staff not employed onsite are not allowed.

7.5 Emergency Work

7.5.1 If, during the course of the Work, the Owner has need to engage the Contractor in emergency work, whether related to the Work or not, the Contractor shall immediately proceed with the emergency work as directed by the Owner under the applicable provisions of the contract. In so doing, Contractor agrees that all provisions of the contract remain in full force and effect and the schedule for the Work is not impacted in any way unless explicitly agreed to in writing by the Owner.

ARTICLE 8
TIME

8.1 Progress and Completion

8.1.1 Contractor acknowledges and agrees that time is of the essence of this Contract

8.1.2 Contract Time is the period of time set forth in the Contract for Construction required for Substantial Completion and Final Completion of the entire Work or portions of the Work as defined in the Contract Documents. Time limits stated in the Contract Documents are of the essence of the Contract. The Contract Time may only be changed by a Change Order. By executing the Contract, the Contractor confirms that the Contract Time is a sufficient period for performing the Work in its entirety.

8.1.3 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, prematurely commence operations on the site or elsewhere prior to the effective date of insurance and bonds required by Article 11 to be furnished by the Contractor.

8.1.4 The Contractor shall proceed expeditiously and diligently with adequate forces and shall achieve Substantial Completion and Final Completion within the time specified in the Contract Documents.

8.2 Delay in Completion

8.2.1 The Contractor shall be liable for all of the Owner's damages for delay in achieving Substantial Completion and/or Final Completion of the entire Work or portions of Work as set forth in the Contract Documents within the Contract Time unless liquidated damages are specifically provided for in the Contract Documents. If liquidated damages are specifically provided for in the Contract for Construction, Contractor shall be liable for such liquidated damages as set forth in Paragraph 8.3

8.2.2 All time limits stated in the Contract are of the essence of the Contract. However, if the Contractor is delayed at any time in the progress of the Work by any act or neglect of the Owner or by the Owner's Representative, by changes ordered in the Work, Force Majeure including but not limited to war, armed conflict, riot, civil commotion or disorder, act of terrorism or sabotage; epidemic, pandemic, outbreaks of infectious disease or any other public health crisis, including quarantine or other employee restrictions, compliance with any law or governmental order, rule, regulation or direction, curfew restriction, act of God or natural disaster such as earthquake, volcanic activity, landslide, tidal wave, tsunami, flood, damage or destruction by lightning, drought; explosion, fire, destruction of machines, equipment, prolonged break-down of transport, telecommunication or electric current; general labor disturbance such as but not limited to boycott, strike and lock-out, occupation of factories and premises, or any other causes beyond the Contractor's reasonable control which the Owner's Representative determines may justify

delay then, upon submission of the Time Impact Schedule Analysis (TIA) justifying the delay called out in Section 4.7 of these General Conditions, the Contract Time may be extended for a reasonable time to the extent such delay will prevent Contractor from achieving Substantial Completion and/or Final Completion within the Contract Time and if performance of the Work is not, was not or would not have been delayed by any other cause for which the Contractor is not entitled to an extension of the Contract Time under the Contract Documents. It shall be a condition precedent to any adjustment of the Contract Time that Contractor provide the Owner's Representative with written notice of the cause of delay within seven (7) days from the occurrence of the event or condition which caused the claimed delay. If a Force Majeure is approved by the Owner as the basis for a delay claim, an adjustment in the contract time to the extent the Force Majeure impacts the schedule is the only remedy. No increase in the contract sum for any reason shall be allowed due to a Force Majeure.

8.2.3 The Contractor further acknowledges and agrees that adjustments in the Contract Time will be permitted for a delay only to the extent such delay (1) is not caused, or could not have been anticipated, by the Contractor, (2) could not be limited or avoided by the Contractor's timely notice to the Owner of the delay, (3) prevents Contractor from completing its Work by the Contract Time, and (4) is of a duration not less than one (1) day. Delays attributable to and within the control of a Subcontractor or supplier shall not justify an extension of the Contract Time.

8.2.4 Notwithstanding anything to the contrary in the Contract Documents, except as otherwise noted in these General Conditions, an extension in the Contract Time, to the extent permitted under this Article, shall be the sole remedy of the Contractor for any (1) delay in the commencement, prosecution or completion of the Work, (2) hindrance or obstruction in the performance of the Work, (3) loss of productivity, or (4) other claims due to or caused by any events beyond the control of both the Owner and Contractor defined herein as Force Majeure. In no event shall the Contractor be entitled to any compensation or recovery of any damages or any portion of damages resulting from delays caused by or within the control of Contractor or by acts or omissions of Contractor or its Subcontractors of any tier or delays beyond the control of both Owner and Contractor. If the Contractor contends that delay, hindrance, obstruction or other adverse condition results from acts or omissions of the Owner, the Owner's Representative or the Architect, Contractor shall provide written notice to the Owner within seven (7) calendar days of the event giving rise to such claim. Contractor shall only be entitled to an adjustment in the Contract Sum to the extent that such acts or omissions continue after the Contractor's written notice to the Owner of such acts or omissions, but in no case shall Force Majeure be the basis of an increase in the Contract sum. The Owner's exercise of any of its rights or remedies under the Contract Documents (including, without limitation, ordering changes in the Work, or directing suspension, rescheduling or correction of the Work) regardless of the extent or frequency of the Owner's exercise of such rights or remedies, shall not be the basis of any Claim for an increase in the Contract Sum or Contract Time. In the event Contractor is entitled to an adjustment in the Contract Sum for any delay, hindrance, obstruction or other adverse condition caused by the acts or omissions of the Owner, the Owner's Representative or the Architect, Contractor shall only be entitled to its actual direct costs caused thereby and Contractor shall not be entitled to and waives any right to special, indirect, or consequential damages including loss of profits, loss of savings or revenues, loss of anticipated profits, labor inefficiencies, idle equipment, home office overhead, and similar type of damages.

8.2.5 If the Contractor submits a progress report or any construction schedule indicating, or otherwise expressing an intention to achieve completion of the Work prior to any completion date required by the Contract Documents or expiration of the Contract Time, no liability of the Owner to the Contractor for any failure of the Contractor to so complete the Work shall be created or implied. Further, the Contractor acknowledges and agrees that even if Contractor intends or is able to complete the Work prior to the Contract Time, it shall assert no Claim and the Owner shall not be liable to Contractor for any failure of the Contractor, regardless of the cause of the failure, to complete the Work prior to the Contract Time.

8.3 Liquidated Damages

8.3.1 If Liquidated Damages are prescribed on the Bid Form and Special Conditions in the Contract Documents, the Owner may deduct from the Contract Sum and retain as Liquidated Damages, and not as penalty or forfeiture, the sum stipulated in the Contract Documents for each calendar day after the date specified for completion of the Work that the entire Work is not substantially complete and/or finally complete.

8.3.2 The Owner's Representative shall establish the date of Substantial completion and the date of Final Completion of the Work which shall be conclusive and binding on the Owner and Contractor for the purpose of determining whether or not Liquidated Damages shall be assessed under terms hereof and the sum total amount due.

8.3.3 Liquidated Damages or any matter related thereto shall not relieve the Contractor or his surety of any responsibility or obligation under this Contract.

ARTICLE 9
PAYMENTS AND COMPLETION

9.1 Commencement, Prosecution, and Completion

9.1.1 The Contractor shall commence Work within five (5) days upon the date of a "Notice to Proceed" from the Owner or the date fixed in the Notice to Proceed. Contractor shall prosecute the Work with faithfulness and diligence, and the

Contractor shall complete the Work within the Contract Time set forth in the Contract Documents.

9.1.2 The Owner will prepare and forward three (3) copies of the Contract and Performance Bond to the bidder to whom the contract for the Work is awarded and such bidder shall return two (2) properly executed prescribed copies of the Contract and Bond to the Owner.

9.1.3 The construction period, when specified in consecutive calendar days, shall begin when the Contractor receives notice requesting the instruments listed in below. Before the Owner will issue Notice to Proceed to permit the Contractor to begin Work, the Owner shall have received the following instruments, properly executed as described in the Contract Documents. The documents below shall have been received by the Owner within fifteen (15) days after receipt of request for documents:

.1 Contract
.2 Bond (See Article 11)
.3 Insurance (See Article 11)
.4 List of Subcontractors of any tier
.5 Affirmative Action Plan (see Article 13.4)

9.1.4 In the event Contractor fails to provide Owner such documents, Contractor may not enter upon the site of the Work until such documents are provided. The date the Contractor is required to commence and complete the Work shall not be affected by the Owner denying Contractor access to the site as a result of Contractor's failure to provide such documents and Contractor shall not be entitled to an adjustment of the Contract Time or Contract sum as a result of its failure to comply with the provisions of this Paragraph

9.1.5 Contracts executed by partnerships shall be signed by all general partners of the partnership. Contracts signed by corporations shall be signed by the President or Vice President and the Secretary or Assistant Secretary. In case the Assistant Secretary or Vice President signs, it shall be so indicated by writing the word "Asst." or "Vice" in front of the words "Secretary" and "President". The corporate seal of the corporation shall be affixed. For all other types of entities, the Contractor and the person signing the Contract on behalf of Contractor represent and warrant that the person signing the Contract has the legal authority to bind Contractor to the Contract.

9.1.6 Any successful bidder which is a corporation organized in a state other than Missouri or any bidder doing business in the State of Missouri under a fictitious name shall furnish, at no cost to the Owner, no later than the time at which the executed Contract for Construction, the Payment Bond, and the Performance Bond are returned, a properly certified copy of its current Certificate of Authority and License to do business in the State of Missouri. No contract will be executed by the Owner until such certificate is furnished by the bidder, unless there already is on file with the Owner a current certificate, in which event, no additional certificate will be required during the period of time for which such current certificate remains in effect.

9.1.7 Within fifteen (15) calendar days of the issuance of a Notice to Proceed, the Contractor shall submit one (1) signed copy of the following instruments. No payment will be processed until all of these instruments are received and approved by the Owner's Representative.

.1 Reproducible progress and payment schedule
.2 Contractor's Schedule of Values
.3 List of material suppliers
.4 Itemized breakdown of all labor rates for each classification. Overhead and profit shall not be included. Payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor or Subcontractors. Any item or expense outside of these categories is not allowed. The expense of performing Work after regular working hours, on Saturdays, Sundays or legal holidays shall not be included in the above, unless approved in writing and in advance by Owner.
.5 Itemized breakdown of anticipated equipment rates (breakout operator rate). Overhead and profit shall not be included. Breakdown for required equipment shall itemize (at a minimum) delivery/ pick-up charge, hourly rate and hours used. Operator hours and rate shall not be included in the equipment breakdown. Contractor must use the most cost-effective equipment available in the area and should not exceed the rates listed in the Rental Rate Blue Book for Construction Equipment (Blue Book). Contractor shall submit documentation for the Blue Book to support the rate being requested.

9.1.8 The Contractor shall be paid electronically using the Owner's web-based payment program with a direct electronic transfer from the Owner's account into the Contractor's account. The Contractor must submit the following information to the Owner's Representative:

.1 Bank Transit Number for the Contractor's bank into which the electronic deposit will be made.
.2 Bank Account Number for the Contractor's account into which the electronic deposit will be made.
.3 Contractor's E-Mail address so that formal notification of the deposit by the Owner can be provided.

9.2 Contract Sum

9.2.1 The Owner shall compensate Contractor for all Work described herein, and in the Contract Documents the Contract

Sum set forth in the Contract for Construction, subject to additions and deletions as provided hereunder.

9.3 Schedule of Values

9.3.1 Within fifteen (15) days after receipt of the Notice to Proceed, the Contractor shall submit to the Owner's Representative a schedule of values allocated to various portions of the Work, prepared in such form and supported by such data to substantiate its accuracy as the Owner's Representative may require. This schedule, unless objected to by the Owner's Representative, shall be used as a basis for reviewing the Contractor's Applications for Payment. The values set forth in such schedule may, at the Owner's option be used in any manner as fixing a basis for additions to or deletions from the Contract Sum.

9.3.2 The progress and payment schedule of values shall show the following:

.1 Enough detail as necessary to adequately evaluate the actual percent complete of any line item on a monthly basis, as determined by the Owner's Representative.

.2 Line items, when being performed by a subcontractor or material supplier, shall correlate directly back to the subcontract or purchase order amount if requested by the Owner's Representative.

9.4 Applications for Payment

9.4.1 The Contractor shall submit monthly to the Owner's Representative and the Architect an itemized Application for Payment for operations completed in accordance with the Schedule of Values. Such application shall be supported by such data substantiating the Contractor's right to payment as the Owner's Representative or Architect may require, such as copies of requisitions from Subcontractors and material suppliers, and reflecting retainage as provided for herein.

9.4.2 Such applications shall not include requests for payment of amounts the Contractor does not intend to pay to a Subcontractor or material supplier

9.4.3 Progress payments shall be made on account of materials and equipment delivered to the site and incorporated in the Work. No payments will be made for materials and equipment stored at the Project site but not yet incorporated into the Work except as provided in Paragraph 9.4.4.

9.4.4 If approved in writing and in advance by Owner, progress payments may be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. Owner may in its sole discretion refuse to grant approval for payments for materials and equipment stored at the Project site but not yet incorporated in the Work. Any approval by Owner for payment for materials and equipment delivered and suitably stored at the site, or stored offsite as noted below, for subsequent incorporation in the Work shall be conditioned upon Contractor's demonstrating that such materials and equipment are adequately protected from weather, damage, vandalism and theft and that such materials and equipment have been inventoried and stored in accordance with procedures established by or approved by the Owner. Nothing in this clause shall imply or create any liability on the part of the Owner for the Contractor's inventory and storage procedures or for any loss or damage to material, equipment or supplies stored on the site, whether incorporated into the work or not. In the event any such loss or damage occurs, the Contractor remains solely responsible for all costs associated with replacement of the affected materials, supplies and equipment including labor and incidental costs, and shall have no claim against the Owner for such loss.

No allowance shall be made in the project pay requests for materials not delivered to the site of the work and incorporated into the work, except as noted below. For the purposes of this Article, Offsite is defined as any location not owned or leased by the Owner. Contractor shall submit a list of materials that they are requesting payment for offsite storage within 60 days of Notice to Proceed.

.1 Items considered to be major items of considerable magnitude, if suitably stored, may be allowed in project pay requests on the basis of ninety percent (90%) of invoices

.2 Determination of acceptable "major items of considerable magnitude" and "suitably stored" shall be made by the Owner's Representative.

.3 Aggregate quantities of materials not considered unique to this project will not be considered for offsite storage payment.

.4 Contractor shall submit to the Owner's Representative a list of the material for which application for payment for offsite storage is anticipated no less than forty-five days prior to the submission of the applicable pay request. The list shall include a material description, applicable division, quantity, and discounts offered to the Owner for early payment. Contractor shall also submit the location the material will be stored and the method of protection

.5 The storage facility shall be subject to approval by the Owner's representative, shall be located within an acceptable distance of the project sites as established by the Owner's Representative and all materials for the Owner's project must be stored separately from all other items within the storage facility and shall be labeled and stored in the name of The Curators of the University of Missouri.

.6 The Owner's representative shall be provided a minimum of two weeks' notice to visit the storage facility and inspect the stored material prior to submission of the pay request.

.7 Upon favorable inspection by the Owner's Representative, the Contractor shall, at the Owner's option, submit a Bill of Sale and Bailment Agreement on forms provided by the Owner's

Representative, transferring title of the material or equipment to The Curators of the University of Missouri.

.8 An invoice provided by the supplier shall be included with the applicable pay request.

.9 The contractor shall remain fully responsible for all items, until acceptance of the project by the Owner.

.10 The contractor shall reimburse all costs incurred by the Owner in inspecting and verifying all material stored offsite, including mileage, airfare, meals, lodging and time, charged at a reasonable hourly rate.

.11 The Contractor shall furnish and maintain insurance covering the replacement cost of the material stored offsite against all losses and shall furnish proof of coverage with the application for payment for material stored offsite.

.12 The Contractor is responsible for all costs related to storage and handling of material stored offsite unless otherwise directed by the Owner's Representative.

9.4.5 The Application for Payment shall constitute a representation by the Contractor to the Owner that the Work has progressed to the point indicated; the quality of the Work covered by the Application for Payment is in accordance with the Contract Documents; and the Contractor is entitled to payment in the amount requested.

9.4.6 The Contractor will be reimbursed for ninety-five percent (95%) of the value of all labor furnished and material installed and computed in the same manner, less all previous payments made. On projects where a bond is not required, the contractor will be reimbursed for ninety percent (90%) of the value of all labor furnished and material installed and computed in the same manner, less all previous payments made

9.5 Approval for Payment

9.5.1 The Owner's Representative will, within fifteen (15) days after receipt of the Contractor's Application for Payment, either approve Contractor's Application for Payment for such amount as the Owner's Representative determines is properly due or notify the Contractor of the Owner's Representative's reasons for withholding certification in whole or in part as provided in Section 9.6.

9.6 Decisions to Withhold Approval

9.6.1 The Owner's Representative may decide not to certify payment and may withhold approval in whole or in part, to the extent reasonably necessary to protect the Owner. If the Owner's Representative is unable to approve payment in the amount of the Application, the Owner's Representative will notify the Contractor as provided in Paragraph 9.5.1. If the Contractor and Owner's Representative cannot agree on a revised amount, the Owner's Representative will promptly issue approval for payment for the amount for which the Owner's Representative is able to determine is due Contractor. The Owner's Representative may also decide not to approve payment or, because of subsequently discovered evidence or subsequent observations, may nullify the whole or a part of approval for payment previously issued, to such extent as may be necessary in the Owner's Representative opinion to protect the Owner from loss because of:

.1 defective or non-compliant Work not remedied, or damage to completed Work;

.2 failure to supply sufficient skilled workers or suitable materials;

.3 third party claims filed or reasonable evidence indicating probable filing of such claims;

.4 failure of the Contractor to make payments properly to Subcontractors or for labor, materials or equipment, Owner may, at its sole option issue joint checks to subcontractors who have presented evidence that it has not been paid in accordance with the Contract;

.5 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;

.6 damage to the Owner or another contractor;

.7 reasonable evidence that the Work will not be completed within the Contract Time or an unsatisfactory rate of progress made by Contractor;

.8 Contractor's failure to comply with applicable Laws;

.9 Contractor's or Subcontractor's failure to comply with contract Prevailing Wage requirements; or

.10 Contractor's failure to carry out the Work in strict accordance with the Contract Documents.

9.6.2 When the above reasons for withholding approval are removed, approval will be made for amounts previously withheld.

9.7 Progress Payments

9.7.1 Based upon Applications for Payment submitted to the Owner by the Contractor and approvals issued by the Owner's Representative, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents.

9.7.2 The period covered by each Application for Payment shall be one (1) calendar month.

9.7.3 The Owner shall make payment to Contractor for amounts due and approved by Owner's Representative not later than thirty (30) days after the Owner approves a properly detailed Application for Payment which is in compliance with the Contract Documents. The Owner shall not have the obligation to process or pay such Application for Payment until it receives an Application for Payment satisfying such requirements.

9.7.4 Based on the Schedule of Values submitted by Contractor, Applications for Payment submitted by Contractor

shall indicate the actual percentage of completion of each portion of Contractor's Work as of the end of the period covered by the Application for Payment.

9.7.5 The Contractor shall promptly pay each Subcontractor and Supplier, upon receipt of payment from the Owner, out of the amount paid to the Contractor on account of such Subcontractor's or supplier's portion of the Work, the amount to which said Subcontractor or supplier is entitled, reflecting percentages actually retained from payments to the Contractor on account of each Subcontractor's or supplier's portion of the Work, in full compliance with state statute. The Contractor shall, by appropriate agreement with each Subcontractor or supplier, require each Subcontractor or supplier to make payments to Sub-subcontractors in similar manner.

9.7.6 Neither the Owner nor Architect shall have an obligation to pay or to see to the payment of money to a Subcontractor of any tier nor a laborer or employee of Contractor except to the extent required by law. Retainage provided for by the Contract Documents are to be retained and held for the sole protection of Owner, and no other person, firm or corporation shall have any claim or right whatsoever thereto.

9.7.7 An approval for payment by Owner's Representative, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

9.8 Failure of Payment

9.8.1 If the Owner is entitled to reimbursement or payment from the Contractor under or pursuant to the Contract Documents, such payment by Contractor shall be made promptly upon demand by the Owner. Notwithstanding anything contained in the Contract Documents to the contrary, if the Contractor fails to promptly make any payment due the Owner, or the Owner incurs any costs and expenses to cure any default of the Contractor or to correct defective Work, the Owner shall have an absolute right to offset such amount against the Contract Sum and may, in the Owner's sole discretion, elect either to: (1) deduct an amount equal to that to which the Owner is entitled from any payment then or thereafter due the Contractor from the Owner, or (2) issue a written notice to the Contractor reducing the Contract Sum by an amount equal to that to which the Owner is entitled.

9.9 Substantial Completion

9.9.1 Substantial Completion is the stage in the progress of the Work as defined in Paragraph 1.1.14 as certified by the Owner.

9.9.2 When the Contractor considers the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall notify the Owner and the Architect. The Owner's Representative will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Owner's Representative's inspection discloses any item which is not in accordance with the requirements of the Contract Documents, the Contractor shall complete or correct such item upon notification by the Owner's Representative. The Contractor shall then submit a request for another inspection by the Owner's Representative to determine Substantial Completion. When the Work or designated portion thereof is substantially complete, the Owner will issue a Certificate of Substantial Completion. Substantial Completion shall transfer from the Contractor to the Owner responsibilities for security, maintenance, heat, utilities, damage to the Work and insurance. In no event shall Contractor have more than thirty (30) days to complete all items on the Punch List and achieve Final Completion. Warranties required by the Contract Documents shall commence on the date of Substantial Completion or as agreed otherwise.

9.9.3 At the date of Substantial Completion, the Contractor may apply for, and if approved by Owner's Representative, the Owner, subject to the provisions herein, shall increase total payments to one hundred percent (100%) of the Contract Sum less one hundred fifty percent (150%) of the value of any incomplete Work and unsettled claims, as determined by the Owner's Representative.

9.10 Partial Occupancy or Use

9.10.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, security, maintenance, heat, utilities, damage to the Work and insurance. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by the Owner's Representative.

9.10.2 Immediately before such partial occupancy or use, the Owner, and Contractor shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work. Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

9.11 Final Completion and Final Payment

9.11.1 Upon receipt of written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Owner's Representative and the Architect will promptly make such inspection and, when the Owner's Representative and Architect find the Work acceptable under the Contract Documents and the Contract fully performed, the Owner's Representative will promptly issue a final approval for payment; otherwise, Owner's

Representative will return Contractor's Final Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application. Submission of a Final Application for Payment shall constitute a further representation that conditions listed in Paragraph 9.11.2 as precedent to the Contractor's being entitled to final payment have been fulfilled. All warranties and guarantees required under or pursuant to the Contract Documents shall be assembled and delivered by the Contractor to the Owner's Representative as part of the final Application for Payment. The final approval for payment will not be issued by the Owner's Representative until all warranties and guarantees have been received and accepted by the Owner.

9.11.2 The Owner will request the Contractor to submit the application for final payment along with a manually signed notarized letter on the Contractor's letterhead certifying that:

.1 Labor costs, prevailing wage rates, fringe benefits and material costs have been paid.

.2 Subcontractors of any tier and manufacturers furnishing materials and labor for the project have fully completed their Work and have been paid in full.

.3 The project has been fully completed in accordance with the Contract Documents as modified by Change Orders.

.4 The acceptance by Contractor of its Final Payment, by check or electronic transfer, shall be and operate as a release of all claims of Contractor against Owner for all things done or furnished or relating to the Work and for every act or alleged neglect of Owner arising out of the Work.

9.11.3 Final Payment constituting the entire unpaid balance due shall be paid by the Owner to the Contractor within thirty (30) days after Owner's receipt of Contractor's Final Application for Payment which satisfies all the requirements of the Contract Documents and Owner's receipt of all information and documents set forth in Section 9.11.

9.11.4 No payment under this Contract, including but not limited to final payment, shall constitute acceptance by Owner of any Work or act not in accordance with the requirements of the Contract Documents.

9.11.5 No recourse shall be had against any member of the Board of Curators, or officer thereof, for any payment under the Contract or any claim based thereon.

ARTICLE 10
PROTECTION OF PERSONS AND PROPERTY

10.1 Safety Precautions and Programs

10.1.1 The Contractor shall at all times conduct operations under this Contract in a manner to avoid the risk of bodily harm to persons or risk of damage to any property. The Contractor shall promptly take precautions which are necessary and adequate against conditions created during the progress of the Contractor's activities hereunder which involve a risk of bodily harm to persons or a risk of damage to property. The Contractor shall continuously inspect Work, materials, and equipment to discover and determine any such conditions and shall be solely responsible for discovery, determination, and correction of any such conditions. The Contractor shall comply with applicable safety laws, standards, codes, and regulations in the jurisdiction where the Work is being performed, specifically, but without limiting the generality of the foregoing, with rules regulations, and standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970 and applicable amendments.

10.1.2 All contractors, subcontractors and workers on this project are subject to the Construction Safety Training provisions 292.675 RSMo.

10.1.3 In the event the Contractor encounters on the site, material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), lead, mercury, or other material known to be hazardous, which has not been rendered harmless, the Contractor shall immediately stop Work in the area affected and report the condition to the Owner's Representative and the Architect in writing. The Work in the affected area shall not thereafter be resumed except by written agreement of the Owner's Representative and Contractor if in fact the material is asbestos or polychlorinated biphenyl (PCB) and has not been rendered harmless. The Work in the affected area shall be resumed in the absence of asbestos or polychlorinated biphenyl (PCB), or when it has been rendered harmless by written agreement of the Owner's Representative and the Contractor. "Rendered Harmless" shall mean that levels of such materials are less than any applicable exposure standards, including but limited to OSHA regulations.

10.2 Safety Of Persons and Property

10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide protection to prevent damage, injury, or loss to:

.1 students, faculty, staff, the public, construction personnel, and other persons who may be affected thereby;

.2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor or the Contractor's Subcontractors of any tier; and

.3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

10.2.2 The Contractor shall give notices and comply with applicable laws, standards, codes, ordinances, rules, regulations, and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury, or loss.

10.2.3 The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, safeguards for safety and protection, including, but not limited to, posting danger signs and other warnings against hazards, promulgating safety regulations, and notifying owners and users of adjacent sites and utilities.

10.2.4 When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise the highest degree of care and carry on such activities under supervision of properly qualified personnel.

10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Article 10 caused in whole or in part by the Contractor, a Subcontractor of any tier, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable, and for which the Contractor is responsible under Article 10, except damage or loss attributable solely to acts or omissions of Owner or the Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's other obligations stated elsewhere in the Contract.

10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents, and the maintaining, enforcing and supervising of safety precautions and programs. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner's Representative and Architect. The Contractor shall hold regularly scheduled safety meetings to instruct Contractor personnel on safety practices, accident avoidance and prevention, and the Project Safety Program. The Contractor shall furnish safety equipment and enforce the use of such equipment by its employees and its subcontractors of any tier.

10.2.7 The Contractor shall not load or permit any part of the construction or site to be loaded so as to endanger its safety.

10.2.8 The Contractor shall promptly report in writing to the Owner all accidents arising out of or in connection with the Work which cause death, lost time injury, personal injury, or property damage, giving full details and statements of any witnesses. In addition, if death, serious personal injuries, or serious property damages are caused, the accident shall be reported immediately.

10.2.9 The Contractor shall promptly notify in writing to the Owner of any claims for injury or damage to personal property related to the work, either by or against the Contractor.

ARTICLE 11
INSURANCE & BONDS

11.1 Insurance

11.1.1 Contractor shall secure from the date of the Contract for Construction and maintain for such periods of time as set forth below, insurance of such types and in such amounts specified below, to protect Contractor, Owner and others against all hazards or risks of loss described below. The form of such insurance together with carriers thereof, in each case, shall be approved by Owner, but, regardless of such approval, it shall be the responsibility of Contractor to maintain the insurance coverages set forth herein.

11.1.2 The contractor shall not be allowed on the Owners property without proof of the insurance coverages set forth herein

11.2 Commercial General Liability

11.2.1 Contractor shall secure and maintain from the date of the Contract and for a period of at least five (5) years from the date of Final Completion of the entire Work Commercial General Liability insurance ("CGL") with a combined single limit of not less than $2,000,000 per occurrence, $5,000,000 general aggregate, $5,000,000 products and completed operations aggregate and $1,000,000 personal injury and advertising injury. General Aggregate should apply per project. An umbrella policy may be used to satisfy these limits. If the General Aggregate is not on a per project basis, the contractor shall provide an additional $2,000,000 general aggregate.

11.2.2 CGL insurance shall be written on a comprehensive form and shall cover claims and liability in connection with or resulting from the Contractor's operations and activities under the Contract, for personal injuries, occupational sickness, disease, death or damage to property of others, including loss of use resulting therefrom, arising out of any operations or activities of the Contractor, its agents, or any Subcontractors of any tier or by anyone directly or indirectly employed by either of them.

11.2.3 CGL insurance shall include premises, operations, independent contractors, products-completed operations, personal injury and advertising injury and liability assumed under an insured contract (including the tort liability of another assumed in a business contract) coverages. In particular, and not by way of any limitation, the CGL

insurance shall cover the Contractor's indemnity obligations contained in the Contract Documents.

11.2.4 There shall be no endorsement or modification of the CGL policy limiting the scope of coverage for liability arising from blasting, explosion, collapse, or underground property damage.

11.2.5 "The officers, employees, and agents of The Curators of the University of Missouri" shall be endorsed as an "additional insured" under the CGL policy. The additional insured status must be conveyed by using the ISO CG 2 10 (2004) edition or equivalent and the ISO CG 20 37 (2004) edition. The policy shall be endorsed to be primary coverage and any other insurance carried by the Owner shall be excess only and will not contribute with Contractors' insurance. To confirm, the Endorsement should accompany the insurance certificate.

11.2.6 Contractor waives all rights against Owner and its agents, officers, representatives, and employees for recovery of damages to the extent those damages are covered by the CGL policy required hereunder.

11.3 Licensed for Use Vehicle Liability

11.3.1 Contractor shall secure and maintain from the date of the Contract for Construction until the date of Final Completion of the entire Work, insurance, to be on comprehensive form, which shall protect Contractor against any and all claims for all injuries and all damage to property arising from the use of automobiles, trucks and motorized vehicles, in connection with the performance of Work under this Contract, and shall cover the operation on or off the site of the Work of all motor vehicles licensed for highway use whether they are owned, non-owned or hired. Such insurance shall include contractual liability coverage and shall provide coverage on the basis of the date of any accident. The liability limits under such policy shall not be less than $2,000,000 combined single limit for bodily injury and property damage per accident.

11.3.2 Contractor waives all rights against Owner and its agents, officers, directors, and employees for recovery of damages to the extent such damages are covered by the automobile liability insurance required hereunder.

11.4 Workers' Compensation Insurance

11.4.1 Contractor shall purchase and maintain workers' compensation insurance and employers' liability insurance which shall protect Contractor from claims for injury, sickness, disease or death of Contractor's employees or statutory employees. The insurance policies required hereunder shall include an "all states" or "other states" endorsement. In case any Work is sublet, Contractor shall require any Subcontractor of any tier to provide the insurance coverages required under this Section 11.4.

11.4.2 Contractor's workers' compensation insurance coverage shall be in compliance with all applicable Laws, including the statutes of the State of Missouri. Contractor's employers' liability coverage limits shall not be less than $1,000,000 each accident for bodily injury by accident or $1,000,000 each employee for bodily injury by disease.

11.5 Liability Insurance General/Other Requirements

11.5.1 Any Consultant/Contractor providing professional design services as part of the contract shall be required to provide and maintain, from the date of this Contract and for a period of ten (10) years after the date of Final Completion, Professional Liability insurance to cover any claims, including but not limited to errors, omissions, and negligence, which may arise from the Design and related Services performed by the Consultant. The minimum limits for such Policy shall be $1,000,000.00 per occurrence/$1,000,000.00 aggregate. The insurance afforded by the policy shall meet the requirements of this Section 11.2 and Section 11.5 relating to CGL Policies, and without limiting the foregoing, shall be extended to cover the liability of "The officers, employees, and agents of The Curators of the University of Missouri", who shall be named as additional insureds therein, and this liability is assumed in writing by the Contractor's Consultant under the written Subcontract described herein. All insurance coverages procured by Contractor shall be provided by agencies and insurance companies acceptable to and approved by Owner. Any insurance coverage shall be provided by insurance companies that are duly licensed to conduct business in the State of Missouri as an admitted carrier. The form and content of all insurance coverage provided by Contractor are subject to the approval of Owner. All required insurance coverages shall be obtained and paid for by Contractor. Any approval of the form, content or insurance company by Owner shall not relieve the Contractor from the obligation to provide the coverages required herein.

11.5.2 All insurance coverage procured by the Contractor shall be provided by insurance companies having policyholder ratings no lower than "A-" and financial ratings not lower than "XI" in the Best's Insurance Guide, latest edition in effect as of the date of the Contract, and subsequently in effect at the time of renewal of any policies required by the Contract Documents. Insurance coverages required hereunder shall not be subject to a deductible amount on a per-claim basis of more than $10,000.00 and shall not be subject to a per-occurrence deductible of more than $25,000.00. Insurance procured by Contractor covering the additional insureds shall be primary insurance and any insurance maintained by Owner shall be excess insurance.

11.5.3 All insurance required hereunder shall provide that the insurer's cost of providing the insureds a defense and appeal, including attorneys' fees, shall be supplementary and shall not be included as part of the policy limits but shall remain the insurer's separate responsibility. Contractor shall cause its insurance carriers to waive all rights of subrogation,

except for Workers' Compensation, against the Owner and its officers, employees and agents.

11.5.4 The Contractor shall furnish the Owner with certificates, Additional Insured endorsements, policies, or binders which indicate the Contractor and/or the Owner and other Contractors (where required) are covered by the required insurance showing type, amount, class of operations covered, effective dates and dates of expiration of policies prior to commencement of the work. Contractor is required to maintain coverages as stated and required to notify the University of a Carrier Change or cancellation within 2 business days. The University reserves the right to request a copy of the policy. Contractor fails to provide, procure, and deliver acceptable policies of insurance or satisfactory certificates or other evidence thereof, the Owner may obtain such insurance at the cost and expense of the Contractor without notice to the Contractor.

11.5.5 With respect to all insurance coverages required to remain in force and affect after final payment, Contractor shall provide Owner additional certificates, policies and binders evidencing continuation of such insurance coverages along with Contractor's application for final payment and shall provide certificates, policies and binders thereafter as requested by Owner.

11.5.6 The maintenance in full current force and effect of such forms and amounts of insurance and bonds required by the Contract Documents shall be a condition precedent to Contractor's exercise or enforcement of any rights under the Contract Documents.

11.5.7 Failure of Owner to demand certificates, policies and binders evidencing insurance coverages required by the Contract Documents, approval by Owner of such certificates, policies and binders or failure of Owner to identify a deficiency from evidence that is provided by Contractor shall not be construed as a waiver of Contractor's obligations to maintain the insurance required by the Contract Documents.

11.5.8 The Owner shall have the right to terminate the Contract if Contractor fails to maintain the insurance required by the Contract Documents.

11.5.9 If Contractor fails to maintain the insurance required by the Contract Document, Owner shall have the right, but not the obligation, to purchase said insurance at Contractor's expense. If Owner is damaged by Contractor's failure to maintain the insurance required by the Contract Documents, Contractor shall bear all reasonable costs properly attributable to such failure.

11.5.10 By requiring the insurance set forth herein and in the Contract Documents, Owner does not represent or warrant that coverage and limits will necessarily be adequate to protect Contractor, and such coverages and limits shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner in the Contract Documents.

11.5.11 If Contractor's liability policies do not contain a standard separation of insureds provision, such policies shall be endorsed to provide cross-liability coverage.

11.5.12 If a part of the Work hereunder is to be subcontracted, the Contractor shall: (1) cover any and all Subcontractors in its insurance policies; (2) require each Subcontractor to secure insurance which will protect said Subcontractor and supplier against all applicable hazards or risks of loss designated in accordance with Article 11 hereunder; and (3) require each Subcontractor or supplier to assist in every manner possible in the reporting and investigation of any accident, and upon request, to cooperate with any insurance carrier in the handling of any claim by securing and giving evidence and obtaining the attendance of witnesses as required by any claim or suit.

11.5.13 It is understood and agreed that the insurance coverages required by the provisions of this Article 11 are required in the public interest and that the Owner does not assume any liability for acts of Contractor or Subcontractors of any tier or their employees in the performance of the Contract or Work.

11.6 Builder's Risk Insurance

11.6.1 The Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the State of Missouri, as an admitted carrier, builder's risk insurance on the entire Work. Such insurance shall be written on a completed value form for the entire Work. The insurance shall apply on a replacement cost basis.

11.6.2 The insurance as required herein shall name as insureds the Owner, Contractor, and all Subcontractors of any tier. The insurance policy shall contain a provision that the insurance will not be canceled, allowed to expire or materially changed until at least thirty (30) days prior written notice has been given to Owner.

11.6.3 The insurance as required herein shall cover the entire Work, including reasonable compensation for Architect's services and expenses made necessary by an insured loss. Insured property shall include portions of the Work located away from the site (including all offsite stored materials) but intended for use at the site and shall also cover portions of the Work in transit, including ocean transit. The policy shall include as insured property scaffolding, falsework, and temporary buildings located at the site. The policy shall cover the cost of removing debris, including demolition as may be made legally necessary by the operation of any law, ordinance, or regulation.

11.6.4 The insurance required herein shall be on an all risk form and shall be written to cover all risks of physical loss or damage to the insured party and shall insure at least against the perils of fire and extended coverage, theft, vandalism,

malicious mischief, collapse, lightening, earthquake, flood, frost, water damage, windstorm and freezing.

11.6.5 If there are any deductibles applicable to the insurance required herein, Contractor shall pay any part of any loss not covered because of the operation of such deductibles.

11.6.6 The insurance as required herein shall be maintained in effect until the earliest of the following dates:

.1 the date which all persons and organization who are insureds under the policy agree in writing that it shall be terminated;

.2 the date on which final payment of this Contract has been made by Owner to Contractor; or

.3 the date on which the insurable interests in the property of all insureds other than the Owner have ceased.

11.6.7 The Owner and Contractor waive all rights against (1) each other and any of their subcontractors of any tier, suppliers, agents and employees, each of the other, (2) the Architect and Architect's consultants, and (3) separate contractors described in Article 6, if any, and any of their subcontractors of any tier, suppliers, agents and employees, for damages caused by fire or other perils to the extent covered by property insurance obtained pursuant to this Section 11.7 or other insurance applicable to the Work, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require of the Architect, Architect's consultants, separate contractors described in Article 6, if any, and the subcontractors of any tier, suppliers, agents, and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, was at fault or was negligent in causing the loss and whether or not the person or entity had an interest in the property damaged.

11.6.8 A loss insured under Contractor's property insurance shall be adjusted by the Owner in good faith and made payable to the Owner for the insureds, subject to requirements of the Contract Documents. The Contractor shall pay Subcontractors of any tier their just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require Subcontractors of any tier to make payments to their Sub-subcontractors in similar manner.

11.7 Bonds

11.7.1 When the Contract sum exceeds Fifty Thousand Dollars ($50,000), the Contractor shall procure and furnish a Performance Bond and a Payment Bond in the form prepared by the Owner, each in an amount equal to one hundred percent (100%) of the Contract Sum, as well as adjustments to the Contract Sum. The Performance Bond shall secure and guarantee Contractor's faithful performance of this Contract, including but not limited to Contractor's obligation to correct defects after final payment has been made as required by the Contract Documents. The Payment Bond shall secure and guarantee payment of all persons performing labor on the Project under this Contract and furnishing materials in connection with this Contract. These Bonds shall be in effect through the duration of the Contract plus the Guaranty Period as required by the Contract Documents.

11.7.2 The bonds required hereunder shall be executed by a responsible surety licensed in the State of Missouri, with a Best's rating of no less than A-/XI. The Contractor shall require the attorney in fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy of this power of attorney indicating the monetary limit of such power.

11.7.3 If the surety of any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to conduct business in the State of Missouri is terminated, or it ceases to meet the requirements of this paragraph, Contractor shall within ten (10) days substitute another bond and surety, both of which must be acceptable to Owner. If Contractor fails to make such substitution, Owner may procure such required bonds on behalf of Contractor at Contractor's expense.

11.7.4 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds to such person or entity.

11.7.5 The Contractor shall keep the surety informed of the progress of the Work, and, where necessary, obtain the surety's consent to or waiver of: (1) notice of changes in the Work; (2) request for reduction or release of retention; (3) request for final payment; and (4) any other material required by the surety. The Owner shall be notified by the Contractor, in writing, of all communications with the surety, as it relates to items one through four. The Owner may, in the Owner's sole discretion, inform surety of the progress of the Work, any defects in the Work, or any defaults of Contractor under the Contract Documents and obtain consents as necessary to protect the Owner's rights, interest, privileges and benefits under and pursuant to any bond issued in connection with the Work.

11.7.6 Contractor shall indemnify and hold harmless the Owner and any agents, employees, representative or member of the Board of Curators from and against any claims, expenses, losses, costs, including reasonable attorneys' fees, as a result of any failure of Contractor to procure the bonds required herein.

ARTICLE 12
UNCOVERING AND CORRECTION OF THE WORK

12.1 Uncovering of the Work

12.1.1 If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the Contract Documents, it shall, if required in writing by the Architect or the Owner's Representative, be uncovered for the Architect's observation and be replaced at the Contractor's expense without change in the Contract Time.

12.1.2 If a portion of the Work has been covered which the Architect or the Owner's Representative has not specifically requested to observe, prior to its being covered, the Architect or the Owner's Representative may request to see such Work, and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, costs of uncovering and replacement shall, by appropriate Change Order, be charged to the Owner. If such Work is not in accordance with the Contract Documents, the Contractor shall pay such costs unless the condition was caused by the Owner or a separate contractor in which event the Owner will be responsible for payment of such costs.

12.2 Correction of the Work

12.2.1 The Architect or Owner's Representative shall have the right to reject Work not in strict compliance with the requirements of the Contract Documents. The Contractor shall promptly correct Work rejected by the Architect or the Owner's Representative for failing to conform to the requirements of the Contract Documents, whether observed before or after final completion and whether or not fabricated, installed, or completed. If Work has been rejected by Architect or Owner's Representative, the Architect or Owner's Representative shall have the right to require the Contractor to remove it from the Project site and replace it with Work that strictly conforms to the requirements of the Contract Documents regardless, if such removal and replacement results in "economic waste." Contractor shall pay all claims, costs, losses and damages caused by or resulting from the correction, removal or replacement of defective, or non-compliant Work, including but not limited to, all costs of repair or replacement of Work of others. The Contractor shall bear costs of correcting, removing and replacing such rejected Work, including additional testing and inspections and compensation for the Architect's services and expenses made necessary thereby. If prior to the date of final payment, the Contractor, a Subcontractor, or anyone for whom either is responsible uses or damages any portion of the Work, including, without limitation, mechanical, electrical, plumbing, and other building systems, machinery, equipment or other mechanical device, the Contractor shall cause such item to be restored to "like new" condition at no expense to the Owner.

12.2.2 If, within twelve (12) months after the date of Final Completion of the Work or designated portion thereof, or after the date for commencement of warranties, or by terms of an applicable special warranty required by the Contract Documents, any of the Work is found not to be in strict accordance with the requirements of the Contract Documents, the Contractor shall correct or remove and replace such defective Work, at the Owner's discretion. Such twelve (12) month period is referred to as the "Guarantee Period." The obligations under this Paragraph 12.2.2 shall cover any repairs, removal, and replacement to any part of the Work or other property caused by the defective Work.

12.2.3 The Contractor shall remove from the site portions of the Work which are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

12.2.4 If the Contractor fails to correct nonconforming Work within a reasonable time, the Owner may correct or remove it and replace such nonconforming Work. If the Contractor does not proceed with correction of such nonconforming Work within a reasonable time fixed by written notice from the Owner, the Owner may take action to correct or remove the nonconforming work at the contractor's expense.

12.2.5 The Contractor shall bear the cost of correcting destroyed or damaged Work or property, whether completed or partially completed, of the Owner or of others caused by the Contractor's correction or removal of Work which is not in accordance with the requirements of the Contract Documents.

12.2.6 Nothing contained in Article 12 shall be construed to establish a period of limitation with respect to other obligations that the Contractor might have under the Contract Documents. Establishment of the twelve (12) month Guarantee Period as described in Article 12 relates only to the specific obligation of the Contractor to correct, remove or replace the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations under the Contract Documents. The requirements of Article 12 are in addition to and not in limitation of any of the other requirements of the Contract for warranties or conformance of the Work to the requirements of the Contract Documents.

12.3 Acceptance of Nonconforming Work

12.3.1 The Owner may accept Work which is not in accordance with the Contract Documents, instead of requiring its removal and correction, in its sole discretion. In Such case the Contract Sum will be adjusted as appropriate and equitable. Such adjustment shall be made whether or not final payment has been made. Nothing contained herein shall impose any obligation upon the Owner to accept nonconforming or defective Work.

ARTICLE 13
MISCELLANEOUS PROVISIONS

13.1 Written Notice

13.1.1 All notices required to be given by the contractor under the terms of this Contract shall be made in writing. Written notice when served by the Owner will be deemed to have been duly served if delivered in person to the individual or a member of the firm or entity or to an office of the corporation for which it was intended, or if delivered at or sent to the last business address known to the party giving notice.

13.2 Rights and Remedies

13.2.1 Duties and obligations imposed by the Contract Documents, and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

13.2.2 No action or failure to act by the Owner, the Architect, or the Owner's Representative will constitute a waiver of a right or duty afforded to the Owner under the Contract Documents, nor will such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed in writing.

13.2.3 The terms of this Contract and all representations, indemnifications, warranties and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion and acceptance of the Work and termination or completion of the Work and shall remain in effect so long as the Owner is entitled to protection of its rights under applicable law.

13.2.4 Contractor shall carry out the Work and adhere to the current construction schedule during all disputes or disagreements with the Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements except as the Owner and Contractor may otherwise agree to in writing.

13.3 Tests and Inspections

13.3.1 Tests, inspections, and approvals of portions of the Work required by the Contract Documents or by laws, ordinances, rules, codes, or regulations shall be made at an appropriate time. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections and approvals with an independent testing laboratory, the Owner's Authorized Agent, or entity acceptable to the Owner, and the Contractor shall bear related costs of tests, inspections, and approvals as required in the Contract Documents. The Contractor shall give the Architect, Owner's Representative, and the Owner's Authorized Agent timely notice of when and where tests and inspections are to be made so the Architect, the Owner's Representative and/or the Owner's Authorized Agent may observe procedures or perform the necessary tests or inspections.

13.3.2 If the Architect, Owner's Representative, or the Owner's Authorized Agent determine that portions of the Work require additional testing, inspection or approval not included in the Contract Documents, or required by law, the Architect, or the Owner's Representative will instruct the Contractor to make arrangements for such additional testing, inspection, or approval by an entity acceptable to the Owner's Representative and the Contractor shall give timely notice to the Architect, the Owner's Representative or the Owner's Authorized Agent, of when and where tests and inspections are to be made so the Architect, Owner's Representative and/or the Owner's Authorized Agent , ~~so~~ may choose that the tests or inspections can be performed or observed. The Owner will bear such costs except as provided elsewhere in Article 13.

13.3.3 If such procedures for testing, inspection, or approval under Article 13 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, the Contractor shall bear all costs made necessary by such failure including those of repeated procedures and compensation for the Architect's and Owner's Authorized Agent's services and expenses.

13.3.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor, and promptly delivered to the Owner's Representative and Architect.

13.3.5 Contractor shall take all necessary actions to ensure that all tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

13.3.6 Contractor shall arrange for and pay for all costs of all testing required by the Contract Documents or any applicable Laws for materials to be tested or certified at or on the place or premises of the source of the material to be supplied. The Owner shall have the right to require testing of all materials at the place of the source of the material to be supplied if not required by the Contract Documents or any applicable Laws. The Owner shall bear the costs of such tests and inspections not required by the Contract Documents or by applicable Laws unless prior defective Work provides Architect or Owner with a reasonable belief that additional defective Work may be found, in which case Contractor shall be responsible for all costs of tests and inspections ordered by the Owner or Architect, whether or not such tests or inspection reveals that Work is in compliance with the Contract Documents.

13.4 Nondiscrimination in Employment Equal Opportunity

13.4.1 The University serves from time to time as a contractor for the United States government. Accordingly, the provider of goods and/or services shall comply with

federal laws, rules and regulations applicable to subcontractors of government contracts including those relating to equal employment opportunity and affirmative action in the employment of minorities (Executive Order 11246), women (Executive Order 11375), persons with disabilities (29 USC 706) and Executive Order 11758, and certain veterans (38 USC 4212 formerly [2012]) contracting with business concerns with small disadvantaged business concerns (Publication L. 95-507). Contract clauses required by the Government in such circumstances are incorporated herein by reference.

13.5 Supplier Diversity Goal Program

13.5.1 The Contractor shall subcontract with diverse firms no less than the amount pledged in the Contractor's Bid and/or the amount accepted by the Owner.

13.5.2 If the Contractor must remove any diverse subcontractor of any tier, the Contractor shall replace the diverse subcontractor of any tier with another diverse subcontractor(s) of equal dollar value to the diverse supplier removed. The Contractor shall immediately notify the Owner's Representative in writing of the Contractor's intent to remove any, and the Contractor's plan to maintain subcontracts with diverse firms of no less than amount pledged in the Contractor's Bid and/or the amount accepted by the Owner. All changes of diverse subcontractor of any tier shall be approved by the Director of Facilities Planning & Development.

13.5.3 If the Contractor fails to meet or maintain the contractor's Supplier Diversity subcontracting pledge, the Contractor shall immediately notify in writing the Owner's Representative, and the Director of Facilities Planning & Development. Such notice shall include a description of the Contractor's good faith effort to comply with their Supplier Diversity subcontracting pledge.

13.5.4 If the Director of Facilities Planning & Development finds the Contractor has failed to comply in good faith with the Owner's Supplier Diversity goal program, the Director may take appropriate action, including but not limited to, declaring the Contractor ineligible to participate in any contracts with the Owner for a period not to exceed six (6) months, and/or directing that the Contractor's actions be declared a material breach of the Contract and that the Contract be terminated.

13.5.5 The Contractor and his subcontractors shall develop, implement, maintain, and submit in writing to the Director of Facilities Planning & Development, an affirmative action program if at least fifty (50) persons in the aggregate are employed under this contract. If less than fifty (50) persons in the aggregate are to be employed under this contract, the Contractor shall submit, in lieu of the written affirmative action program, a properly executed "Affidavit for Affirmative Action" in the form as included in the Contract Documents. For the purpose of this section, an "Affirmative Action Program" means positive actions to influence all employment practices (including, but not limited to, recruiting, hiring, promoting, and training) in providing equal employment opportunity regardless of race, color, sex, national origin, religion, age (where the person affected is between 40 and 70), disabled and Vietnam-era veteran status, and handicapped otherwise qualified status. Such affirmative action program shall include:

.1 A written policy statement committing the total organization to affirmative action and assigning management responsibilities and procedures for evaluation and dissemination.

.2 The identification of a person designated to handle affirmative action.

.3 The establishment of non-discriminatory selection standards, objective measures to analyze recruitment, an upward mobility system, a wage and salary structure, and standards applicable to lay-off, recall, discharge, demotion, and discipline.

.4 The exclusion of discrimination from collective bargaining agreements.

.5 Performance of an internal audit of the reporting system to monitor execution and to provide for future planning.

13.5.6 In the enforcement of this non-discrimination requirement, the Owner may use any reasonable procedures available, including but not limited to: requests, reports, site visits, and inspection of relevant documents of Contractors and Subcontractors of any tier. The contractor shall submit a final Affidavit of Supplier Diversity Participation for each diverse firm at the end of the project stating the actual amount paid to the diverse firm.

13.6 Wage Rates (If the contract amount is less than $75,000, the requirements of this section will not apply. Any contract adjustments that increase the contract above $75,000 will be subject to this section.)

13.6.1 The Contractor shall pay workers employed in the execution of this contract in full each week and not less than the predetermined wage rates and overtime for work of a similar character that have been made a part of this Contract. These rates are determined by the University of Missouri Director of Facilities Planning and Development. The rates are based on wage rates published in the Annual Wage Orders of the Missouri Department of Labor and Industrial Relations (MDLIR). The Contractor is to use MDLIR 8 CSR 30-3.020; .030; .040, .060 in determining the appropriate occupational titles and rates for workers used in the execution of this contract. All determinations and/or interpretations regarding wage rates and classification of workers will be made by the office of the University of Missouri Director of Facilities Planning and Development. The Contractor is responsible for the payment of the aggregate of the Basic Hourly Rate and the Total Fringe Benefits to the workers on the project. Fringe benefit payments may be made to the worker in cash, or irrevocably made by a Contractor or Subcontractor to a trustee or to a third person pursuant to a fund, plan or program, or pursuant to an enforceable

commitment, or any combination thereof, to carry out a financially responsible plan or program which was communicated in writing to the workmen affected, for medical or hospital care, pensions on retirement or death, compensation for injuries or illness resulting from occupational activity, or insurance to provide any of the foregoing, for unemployment benefits, life insurance, disability and sickness insurance, accident insurance, for vacation and holiday pay, for defraying costs of apprenticeship or other similar programs, or for other bona fide fringe benefits, but only where the Contractor or Subcontractor is not required by other federal or state law to provide any of the benefits as referenced in §290.210(5) RSMo 1994. Pay for travel, mileage, meals, bonuses, or other expenses are not fringe benefits and cannot be considered part of the workers wage rate. The Contractor shall not make any deductions for food, sleeping accommodations, transportation, use of small tools, uniforms, or anything of any kind or description, unless the Contractor and employee enter into an agreement in writing at the beginning of the worker's term of employment, and such agreement is approved by the Owner. In the event the contract contains more than one wage determination the Contractor shall comply with both.

13.6.2 The Contractor shall submit to the Owner with the Contractor's periodic pay request, certified payroll records for labor performed by the Contractor and Subcontractors of any tier. The Contractor shall submit all required certified payroll information records electronically in pdf format using the Owner's web-based payment program. The certified payroll forms shall contain the name, address, personal identification number, and occupational title of the workers as well as the hours they work each day. The Owner's acceptance of certified payroll records does not in any way relieve the Contractor of any responsibility for the payment of prevailing wages to workers on the project. The Contractor shall also maintain copies of the certified payroll records. The Owner may, at any time, request copies of, and/or inspect all of the Contractor's payroll records for the Work to verify compliance. The Contractor shall furnish the Owner copies of payroll records within 10 days of the Owner's written request. The Contractor shall provide copies of workers I-9 forms within 24 hours of written notice. (If applicable, and required by Owner, the Contractor will demonstrate that the Contractor is enrolled and participating in a federal work authorization program with respect to the employees working in connection with this project.) Such payroll records shall be maintained in accordance with Article 13.7.1 and shall be available for inspection for two (2) years after final completion of the Work. The contractor further agrees, in the event the records are not presented as requested, he will abide by any decision made by the Owner regarding underpayment of wages to workers and amounts owed them as well as liquidated damages for underpayment of wages. Falsification of the certified payroll records may result in the debarment of the contractor or subcontractor from future work with the University.

13.6.3 The acquisition of products or services is subject to the supplier's conformance to the rules and regulations of the President's Committee on Equal Employment Opportunity (41 CFR, Ch. 60).

13.6.4 The Contractor shall comply with the Copeland Regulations of the Secretary of Labor (29 CFR, Part 3), which are incorporated herein by reference. In addition, the Weekly Statement of Compliance required by these Regulations shall also contain a statement that the applicable fringe benefits paid are equal to or greater than those set forth in the minimum wage decision.

13.6.5 Contractor acknowledges that violation of the requirements of Article 13.6 result in additional costs to Owner, including, but not limited to, cost of construction delays, of additional work for Owner's staff and legal expense. The cost of Contractor's violation of the provisions of Article 13.6 would be and is difficult to determine and establish. In the event that Contractor fails to comply with the provisions of this Article 13.6, Owner shall be entitled to retain or recover from the Contractor, as liquidated damages and not as a penalty, the sum of Fifty Dollars ($50.00) per day per individual who is paid less than the applicable prevailing wage, to approximate the investigative cost resulting to the Owner for such violations. To approximate the delay costs, Owner shall be entitled to retain or recover from the Contractor, as liquidated damages and not as a penalty, the sum of One Hundred Dollars ($100.00) per day for each day the Contract cannot be closed out and final payment made because of Contractor's failure to comply with the provisions of this Article 13.6. Such liquidated damages shall be collected regardless of whether the Work has been completed. The liquidated damages and other amounts set forth in this Article 13.6 shall be in addition to all other liquidated damages the Owner may be entitled as set forth in the Contract Documents.

13.6.6 The Owner may deduct liquidated damages described Article 13 and the amounts set forth in Article 13 from any unpaid amounts then or thereafter due the Contractor under the Contract. Any liquidated damages not so deducted from any unpaid amounts due the Contractor shall be payable to the Owner at the demand of the Owner.

13.6.7 The Contractor shall specifically incorporate the obligations of Article 13 into the subcontracts, supply agreements and purchase orders for the Work and require the same of any Subcontractors of any tier.

13.6.8 Contractor acknowledges and recognizes that a material factor in its selection by the Owner is the Contractor's willingness to undertake and comply with the requirements of this Article 13.6. If Contractor fails to comply with the provisions of this Article 13.6, Owner may, in its sole discretion, immediately terminate the Contract

upon written notice. The rights and remedies of Owner provided herein shall not be exclusive and are in addition to other rights and remedies provided by law or under this Contract.

13.6.9 Only such workers who are individually registered in a bona fide apprenticeship program approved by the U.S. Department of Labor, Office of Apprenticeship can be paid less than the journeyperson rate of pay. "Entry Level Workers; must be registered apprentices. The apprenticeship ratio will be one to one with a journeyperson of the same classification. Any worker not registered as an apprentice per this section will be paid as a journeyperson.

13.6.10 The Contractor shall post the wage rates for the contract in a conspicuous place at the field office on the project. On projects where there is no field office the Contractor may post the wage rates at their local office, as long as they provide a copy of the wage rates to a worker upon request. The wage rates shall be kept in a clearly legible condition for the duration of the project.

13.6.11 Neither the Contractor, nor any Subcontractor of any tier, nor any person hired by them or acting on their behalf, shall request or demand that workers pay back, return, donate, contribute, or give any part, or all, of said workers wages, salary, or any thing of value, upon the statement, representation or understanding that failure to comply with such request or demand will prevent such worker from procuring or retaining employment. The exception being to an agent or representative of a duly constituted labor organization acting in the collection of dues or assessments of such organization.

13.6.12 No contractor or subcontractor may directly or indirectly receive a wage subsidy, bid supplement, or rebate for employment on this project if such wage subsidy, bid supplement, or rebate has the effect of reducing the wage rate paid by the employer on a given occupational title below the prevailing wage rate as provided in contract. In the event a wage subsidy, bid supplement, or rebate is provided or received, the entity receiving such subsidy, supplement, or rebate shall report the date and amount of such subsidy, supplement, or rebate to the University within thirty days of receipt of payment. This disclosure report shall be a matter of public record. Any employer not in compliance with this Article shall owe to the University double the dollar amount per hour that the wage subsidy, bid supplement, or rebate has reduced the wage rate paid by the employer below the prevailing wage rate for each hour that work was performed.

13.6.13 Time and one-half overtime will be paid on all hours over 10 hours per day or 40 hours per week. The wage rate is the total of the "Basic Hourly Rate" plus "Total Fringe Benefits" or the "public works contracting minimum wage". For all work performed on a Sunday or Holiday, not less than twice the prevailing hourly rate of pay or public works contracting minimum wage will apply. Holidays are as follows: January first, the last Monday in May, July fourth, the first Monday in September, November 11, the fourth Thursday in November, December twenty-fifth. If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

13.7 Records

13.7.1 The Owner, or any parties it deems necessary, shall have access to and the right to examine any accounting or other records of the Contractor involving transactions and Work related to this Contract for five (5) years after final payment or five (5) years after the final resolution of any on going disputes at the time of final payment. All records shall be maintained in accordance with generally accepted accounting procedures, consistently applied. Subcontractors of any tier shall be required by Contractor to maintain records and to permit audits as required of Contractor herein.

13.8 Codes and Standards

13.8.1 The Work shall be performed to comply with the International Code Council (ICC) Codes, and the codes and standards noted below. The latest editions and supplements of these Codes and Standards in effect on the date of the execution of the Contract for Construction shall be applicable unless otherwise designated in the Contract Documents. Codes and standards required by accreditation agencies will also be used unless the ICC requirements are more stringent. In the event that special design features and/or construction systems are not covered in the ICC codes, the applicable edition of the National Fire Protection Association (NFPA) family of standards and/or the NFPA 101 Life Safety Code shall be used.

.1 ICC International Building Code and reference standards
.2 ICC International Plumbing Code
.3 ICC International Mechanical Code
.4 ICC International Fire Code
.5 ICC International Fuel Gas Code
.6 NFPA 70 National Electric Code (NEC)
.7 Americans with Disabilities Act – Standards for Accessible Design.
.8 American National Standard Safety Code for Elevators, Dumbwaiters, Escalators, and Moving Walks as published by the American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI) A17.1
.9 NFPA 101 Life Safety Code (as noted above)
.10 American Concrete Institute (ACI)
.11 American National Standards Institute (ANSI)
.12 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
.13 American Refrigeration Institute (ARI)
.14 American Society for Testing and Materials (ASTM)
.15 Missouri Standard Specification for Highway Construction, Missouri State Highway Commission

.16 National Electrical Manufacturers Association (NEMA)

.17 Underwriter's Laboratories, Inc. (UL), Federal Specifications

.18 Williams Steiger Occupational Safety and Health Act of 1970 (OSHA)

13.9 General Provisions

13.9.1 Any specific requirement in this Contract that the responsibilities or obligations of the Contractor also apply to a Subcontractor is added for emphasis and are also hereby deemed to include a Subcontractor of any tier. The omission of a reference to a Subcontractor in connection with any of the Contractor's responsibilities or obligations shall not be construed to diminish, abrogate or limit any responsibilities or obligations of a Subcontractor of any tier under the Contract Documents or the applicable subcontract.

13.9.2 This Contract shall be interpreted, construed, enforced, and regulated under and by the laws of the State of Missouri. Whenever possible, each provision of this Contract shall be interpreted in a manner as to be effective and valid under applicable law. If, however, any provision of this Contract, or a portion thereof, is prohibited by law or found invalid under any law, only such provision or portion thereof shall be ineffective, without invalidating or affecting the remaining provisions of this Contract or valid portions of such provision, which are hereby deemed severable. Contractor and Owner further agree that in the event any provision of this Contract, or a portion thereof, is prohibited by law or found invalid under any law, this Contract shall be reformed to replace such prohibited or invalid provision or portion thereof with a valid and enforceable provision which comes as close as possible to expressing the intention of the prohibited or invalid provision.

13.9.3 Contractor and Owner each agree that the State of Missouri Circuit Court for the County where the Project is located shall have exclusive jurisdiction to resolve all Claims and any issue and disputes between Contractor and Owner. Contractor agrees that it shall not file any petition, complaint, lawsuit or legal proceeding against Owner in any other court other than the State of Missouri Circuit Court for the County where the Project is located.

13.9.4 Owner's total liability to Contractor and anyone claiming by, through, or under Contractor for any Claim, cost, loss, expense, or damage caused in part by the fault of Owner and in part by the fault of Contractor or any other entity or individual shall not exceed the percentage share that Owner's fault bears to the total fault of Owner, Contractor and all other entities and individuals as determined on the basis of comparative fault principles.

13.9.5 Contractor agrees that Owner shall not be liable to Contractor for any special, indirect, incidental, or consequential damage whatsoever, whether caused by Owner's negligence, fault, errors or omissions, strict liability, breach of contract, breach of warranty or other cause or causes whatsoever. Such special, indirect, incidental or consequential damages include, but are not limited to loss of profits, loss of savings or revenue, loss of anticipated profits, labor inefficiencies, idle equipment, home office overhead, and similar types of damages.

13.9.6 Nothing contained in this Contract, or the Contract Documents shall create any contractual relationship with or cause of action in favor of a third party against the Owner.

13.9.7 No member or officer of the Board of Curators of the University incurs or assumes any individual or personal liability under the Contract or by reason of the default of the Owner in the performance of any terms thereof. Contractor releases and discharges all members or officers of the Board of Curators of the University from any liability as a condition of and as consideration for the award of the Contract to Contractor.

13.9.8 The Contractor hereby binds itself, its partners, successors, assigns and legal representatives to the Owner in respect to covenants, agreements and obligations contained in the Contract Documents. Contractor shall not assign the Contract or proceeds hereof without written consent of the Owner. If Contractor attempts to make such an assignment without such consent, it shall be void and confer no rights on third parties, and Contractor shall nevertheless remain legally responsible for all obligations under the Contract. The Owner's consent to any assignment is conditioned upon Contractor entering into a written assignment which contains the following language: "it is agreed that the funds to be paid to the assignee under this assignment are subject to performance by the Contractor and to claims and to liens for services rendered or materials supplied for the performance of the Work required in said Contract in favor of all persons, firms, corporations rendering such services or supplying such materials."

13.10 Certification

13.10.1 The contractor certifies to the best of its knowledge and belief that it and its principals are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency in accordance with Executive Order 12549 (2/18/86).

13.10.2 If this contract is for $100,000 or more, and if the Contractor is a company with ten (10) or more employees, then Contractor certifies that it, and any company affiliated with it, does not boycott Israel, and will not boycott Israel during the term of this Contract. In this paragraph, the terms "company" and "boycott Israel" shall have the meanings described in Section 34.600 of the Missouri Revised Statutes.

ARTICLE 14
TERMINATION OR SUSPENSION OF THE CONTRACT

14.1 Termination by Owner for Cause

14.1.1 In addition to other rights and remedies granted to Owner under the Contract Documents and by law, the Owner may terminate the Contract if the Contractor:

.1 refuses or fails to supply enough properly skilled workers, superintendents, foremen, or managers;

.2 refuses or fails to supply sufficient or proper materials;

.3 fails to make payment to Subcontractors for materials or labor in accordance with the respective agreements between the Contractor and the Subcontractors;

.4 disregards laws, ordinances, rules, codes, regulations or orders of an authority having jurisdiction;

.5 disregards the authority of the Owner's Representative, Architect, or Owner's Authorized Agent;

.6 breaches any warranty or representations made by the Contractor under or pursuant to the Contract Documents;

.7 fails to furnish the Owner with assurances satisfactory to the Owner evidencing the Contractor's ability to complete the Work in compliance with all the requirements of the Contract Documents;

.8 fails after commencement of the Work to proceed continuously with the construction and completion of the Work for more than ten (10) days, except as permitted under the Contract Documents;

.9 fails to maintain a satisfactory rate of progress with the Work or fails to comply with approved progress schedules; or

.10 violates in any substantial way any provisions of the Contract Documents.

14.1.2 When any of the above reasons exist, the Owner may, without prejudice to any other rights or remedies of the Owner, terminate this Contract by delivering a written notice of termination to Contractor and Contractor's surety, and may:

.1 take possession of the site and of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;

.2 accept assignment of subcontracts pursuant to Paragraph 5.3; and

.3 finish the Work by whatever reasonable method the Owner may deem expedient, including turning the Work over to the surety.

14.1.3 The Contractor, in the event of a termination under Section 14.1, shall not be entitled to receive any further payments under the Contract until the Work is completed in its entirety. Then, if the unpaid balance under the Contract shall exceed all expenses of the Owner in finishing the Work, including additional compensation for the Architects services and expenses made necessary thereby, such excess will be paid to the Contractor; but, if such expenses of Owner to finish the Work shall exceed the unpaid balance, the Contractor and its surety shall be liable for, and shall pay the difference and any damages to the Owner. The obligation of the Contractor and its surety for payment of said amounts shall survive termination of the Contract.

14.1.4 In exercising the Owner's right to secure completion of the Work under any of the provisions hereof, the Owner shall have the right to exercise the Owner's sole discretion as to the manner, methods, and reasonableness of costs of completing the Work.

14.1.5 The rights of the Owner to terminate pursuant to Article 14.1 will be cumulative and not exclusive and shall be in addition to any other remedy provided by law or the Contract Documents.

14.1.6 Should the Contractor fail to achieve Final Completion of the Work within thirty (30) calendar days following the date of Substantial Completion, the Owner may exercise its rights under Article 14.1.

14.2 Suspension by the Owner for Convenience

14.2.1 The Owner may, without cause, order the Contractor in writing to suspend, delay, or interrupt the Work in whole or in part for such period of time as the Owner may determine.

14.2.2 An adjustment will be made to the Contract Sum for increases in the cost of performance of the Contract caused by suspension, delay or interruption. However, in the event of a suspension under this Article 14.2, Contractor hereby waives and forfeits any claims for payment of any special, indirect, incidental or consequential damages such as lost profits, loss of savings or revenue, loss of anticipated profits, idle labor or equipment, home office overhead, and similar type damages. No adjustment will be made to the extent:

.1 that performance is, was, or would have been so suspended, delayed or interrupted by another cause for which the Contractor in whole or in part is responsible, or

.2 that an equitable adjustment is made or denied under another provision of this Contract.

14.3 Owner's Termination for Convenience

14.3.1 The Owner may, at any time, terminate the Contract in whole or in part for the Owner's convenience and without cause. Termination by the Owner under this Paragraph shall be by a notice of termination delivered to the Contractor specifying the extent of termination and the effective date.

14.3.2 Upon receipt of a notice of termination for convenience, the Contractor shall immediately, in accordance with instructions from the Owner, proceed with performance

of the following duties regardless of delay in determining or adjusting amounts due under this Paragraph:

.1 cease operation as specified in the notice;

.2 place no further orders and enter into no further subcontracts for materials, labor, services or facilities except as necessary to complete Work not terminated;

.3 terminate all subcontracts and orders to the extent they relate to the Work terminated;

.4 proceed to complete the performance of Work not terminated; and

.5 take actions that may be necessary, or that the Owner may direct, for the protection and preservation of the terminated Work.

14.3.3 Upon such termination, the Contractor shall recover as its sole remedy payment for Work properly performed in connection with the terminated portion of the Work prior to the effective date of termination and for items properly and timely fabricated off the Project site, delivered and stored in accordance with the Owner's instructions and for all Owner approved claims, costs, losses and damages incurred in settlement of terminated contracts with Subcontractors and suppliers. The Contractor hereby waives and forfeits all other claims for payment and damages, including, without limitation, anticipated profits, consequential damages and other economic losses.

14.3.4 The Owner shall be credited for (1) payments previously made to the Contractor for the terminated portion of the Work, (2) claims which the Owner has against the Contractor under the Contract and (3) the value of the materials, supplies, equipment, or other items that are to be disposed of by the Contractor that are part of the Contract Sum.

14.3.5 Upon determination by a court that termination of Contractor or its successor in interest pursuant to Paragraph 14.1 was wrongful, such termination will be deemed converted to a termination for convenience pursuant to Paragraph 14.3, and Contractor's sole and exclusive remedy for wrongful termination is limited to recovery of the payments permitted for termination for convenience as set forth in Paragraph 14.3.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 1.E
SPECIAL CONDITIONS

1. DEFINITIONS

a. "Drawings"
Drawings referred to in and accompanying Project Manual consist of Drawings prepared by and bearing name of below defined Architect, bearing:

b. Architect
Clark & Enersen
2020 Baltimore, Suite 300
Kansas City, Missouri 64108
816-474-8237 p.

c. Mechanical, Plumbing & Electrical Engineer
Clark & Enersen
2020 Baltimore, Suite 300
Kansas City, Missouri 64108
816-474-8237 p.

d. Structural Engineer
Leigh + O'Kane
250 NE Mulburry Street, Suite 201
Lee's Summit, MO 64086
816.444.3144

e. Civil Engineer
SK Design Group, Inc.
4600 College Blvd. Suite 100
Overland Park, KS 66211
913-451-1818 p.

f. Other Definitions: See Article 1., General Conditions.

2. SPECIAL SCHEDULING REQUIREMENTS

a. Special scheduling requirements supplemental to the bid form.

(1) Contractor will not have access to the construction area prior to Owner's notice to proceed to perform any demolition or construction activities, unless notified otherwise by Owner's Representative.

(2) Project sequence and inter-project dependencies must be maintained in successful bidder's schedule. Schedule development shall include, but not limited to MU work activities of Controls, TAB, 3rd Party Commissioning, and Inspections and Testing.

(3) During the construction period all heating ventilation & air conditioning air distribution system components including but not limited to the air handler, supply & return duct, variable volume devices and dampers shall be protected from environmental contaminants including but not limited to dust, debris and fungi during transportation, installation and project activities prior to system start-up.

(4) Prior to start-up of the HVAC equipment/system, including but not limited to, make-up air units, air handling units, supply, return, and exhaust duct for any purpose, the construction project area shall be complete of all dirty work

activities. The entire work area in which the system serves shall be thoroughly cleaned by the contractor.

(5) Owner has specific requirements for notifications regarding coordination and utility shut-downs and tie-ins. These are described further in Division1

(6) Working Hours

a) Normal working hours are defined as weekdays, 7:00 am to 5:00 pm.
b) Night hours are defined as Monday thru Thursday after 5:00 pm and before 6:00 am.
c) Weekend Hours are defined as after 6:00 pm Friday until 4:00 am Monday

(7) Owner has retained a 3rd party commissioning agent. Contractor shall allow for and incorporate commissioning agent's tasks into their construction schedule.

(8) Utility shut-downs, outages and tie-ins: All such work may be done during normal, night, and/or weekend hours. All such work shall be done continuously until fully restored. Contractor shall submit a written plan outlining the required shut-downs, outages, and tie-in at least fourteen (14) days prior to starting the work. Utility shut-downs shall be reviewed, coordinated and approved by the Owner's Representative. Utility outage request is available from owner and must be filled out by the contractor. Steam work requiring prolonged shutdown is restricted to summer months and chilled water work requiring prolonged shutdown is restricted to Oct-Mar.

(9) Owner installed equipment provision: owner will complete connections of Owner supplied equipment as coordinated and approved by Owner's Representative.

3. SCOPE OF WORK

a. The Contractor shall furnish all labor, materials, tools, equipment necessary for, and incidental to, construction of this project as indicated on Drawings and specified herein.

b. Work shall include everything requisite and necessary to finish work properly, notwithstanding that every item of labor or materials or accessories required to make project complete may not be specifically mentioned.

c. General Description of Work:

(1) Project consists of a new 1 story addition to the existing NextGen Center of Excellence for Influenza Research.

(2) Demolition shall consist of interior ceiling and wall construction and exterior walls for connection to new proposed addition.

(3) Architectural work shall consist of new exterior enclosure, interior walls, doors, ceilings, flooring, laboratory casework.

(4) Structural work shall consist of new piers, concrete foundations, and interior wall and ceiling framing.

(5) Mechanical work shall consist of new AHU's, VAV's, exhaust fans, ductwork, piping, control wiring, and other associated items per the contract documents.

(6) Electrical work shall consist of new normal and emergency power systems including a new transformer location and a new generator. Electrical work also

includes new lighting, electrical devices, and low voltage rough in.

(7) New plumbing work shall consist of new fixtures and piping along with new sanitary tie in. Piping shall include domestic and animal supply and waste water systems.

(8) Fire protection work shall consist of a new fire sprinkler system throughout the new addition along with tie in to the existing fire alarm system.

4. LOCATION

Work shall be performed under this Contract on campus of the University of Missouri - Columbia at the Middlebush Farm Extension Site.

5. NUMBER OF CONSTRUCTION DOCUMENTS

a. The Owner's Representative will furnish the Contractor a digital copy of executed Contract and a complete set of Drawings and Specifications in pdf format.

b. Hard copy prints of any documents (bid or explanatory) will be printed at the Contractor's expense through a printer of their choosing.

c. The Owner will furnish explanatory and changed Drawings in pdf format to Contractor as issued during project.

d. The Owner will provide electronic data files to the Contractor for their convenience and use in progressing the Work and the preparation of shop drawings or other submittal requirements required for construction of the referenced project. The electronic data files shall reflect Construction Documents and Bid Addenda only. These files will be transmitted subject to the following terms and conditions:

(1) The Owner makes no representation as to the compatibility of these files with the Contractor's hardware or software.

(2) Data contained on these electronic files shall not be used by the Contractor or anyone else for any purpose other than as a convenience in progressing the Work or in the preparation of shop drawings or other required submittals for the referenced project. Any other use or reuse by the Contractor or by others will be at their own sole risk and without liability or legal exposure to Owner. The Contractor agrees to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against the Owner and its consultants, contractors, agents, employees, and representatives that may arise out of or in connection with the use of the electronic files transmitted.

(3) Furthermore, the Contractor shall, to the fullest extent permitted by law, indemnify and hold harmless the Owner and its consultants, contractors, agents, employees, and representatives, against all damages, liabilities or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.

(4) These electronic files are not contract documents. Differences may exist between these electronic files and corresponding hard-copy construction documents. The Owner makes no representation regarding the accuracy or completeness of the electronic files you receive. In the event that a conflict arises between the signed or sealed hard-copy construction documents prepared by the Consultant and the electronic files, the signed and sealed hard-copy construction documents shall govern. The Contractor is responsible for determining if any conflict exists. By use of these electronic files, the Contractor is not relieved of their duty to fully comply with the contract documents.

(5) Because information presented on the electronic files can be modified, unintentionally or otherwise, the Owner reserves the right to remove all indications of ownership and/or involvement from each electronic display.

(6) Under no circumstances shall delivery of the electronic files be deemed a sale by the Owner and no warranties are made, either expressed or implied, of merchantability and fitness for any particular purpose. In no event shall the Owner be liable for any loss of profit, or any consequential damages as a result of use or reuse of these electronic files.

6. SUBMITTALS

a. The Contractor shall submit for approval to the Architect, equipment lists and Shop Drawings, as expediently as possible. Failure of the Contractor to submit Shop Drawings in a timely manner will result in the Owner holding back Contractor payments. (See General Conditions)

b. The material and equipment lists shall be submitted and approved before any material or equipment is purchased and shall be corrected to as-built conditions before the completion of the project.

c. The Contractor shall submit electronic versions of all required Shop Drawings, material and equipment lists. The Contractor shall upload all Shop Drawings to a secure information sharing website determined by the Owner notifying the Owner and Consultant that these shop drawings are available for review. Each submittal shall have the General Contractors digital stamp affixed to the first page signifying their review and acceptance. Review comments, approvals, and rejections will be posted on this same site with notification to the contractor. Submittals requiring a professional seal shall be submitted hard copy with a manual seal affixed.

(1) The Contractor shall identify each submittal item with the following:

(a) Project Title and Location
(b) Project Number
(c) Supplier's Name
(d) Manufacturer's Name
(e) Contract Specification Section and Article Number
(f) Contract Drawing Number
(g) Acrobat file name: Spec Section Times Submitted-Spec Title: 033000 _01-Cast In Place Concrete.pdf

(2) Reference the accompanying Shop Drawing and Submittal Log at the end of this section (1.E.3) for required submittal information.

d. The Contractor shall submit to the Architect four (4) bound copies of all required Operating Instructions and Service Manuals for the Architect's and the Owner's sole use prior to completing 50% of the adjusted contract. Payments beyond 50% of the contract amount may be withheld until all Operating Instructions and Service Manuals are received as referenced in the accompanying Operating Instructions and Service Manual Log at the end of this section (1.E.4).

e. The Contractor shall submit to the Owner's Representative all items referenced in the accompanying Closeout Log (1.E.5) within 30 days following substantial completion of the work. The Owner's Representative will maintain the closeout log and include as an agenda item at all coordination meetings.

7. NOTIFICATION

Before beginning Demolition Work or service outages, the Contractor shall provide, at minimum, seventy-two (72) hours advance notice to Owner's Representative for purpose of verifying utility

locations including, but not limited to, gas, telecommunications, electric, water, and sewer. Contractor shall minimize the number of outages, minimize the length of outages and related work shall be continuous until the utility is restored.

8. USE OF PREMISES

a. Access: Access to construction site shall be as indicated on Drawings and as directed by the Owner's Representative.

b. Parking:

(1) Parking or driving on sidewalks, landscaped areas, within fire and service lanes or generally in areas not designated for vehicular traffic is prohibited except as allowed in the contract documents. Violation of this requirement may result in ticketing and/or towing at the vehicle owner's expense and suspension of progress payments.

c. Storage of materials: The Contractor shall store all materials within project limits. The Contractor shall confine apparatus, materials, and operation of workers to location established by the Owner's Representative. The Contractor shall not unreasonably encumber premises with materials. In addition, storage trailer locations may be available within 1-1/2 miles of project site as directed by the Owner's Representative. Storage trailer locations shall be subject to approval by the Owner's Representative and are available to the Contractor without cost.

Provisions for obtaining power, including temporary extensions, shall be furnished and maintained by the Contractor. Upon completion of the work, such extensions shall be removed and any damage caused by use of such extensions shall be repaired to the satisfaction of the Owner's Representative, at no cost to the Owner.

d. Restroom: The Contractor shall provide and maintain, in a sanitary condition, chemical type portable toilet facilities at work site for use by his personnel. Toilets and toilet location shall be subject to approval by the Owner's Representative.

e. Smoking is prohibited at the University of Missouri and all properties owned, operated, leased or controlled by the University of Missouri. Violation of the policy is defined as smoking any tobacco products, including e-cigarettes.

f. Landfill: The Contractor shall not use the Owner's landfill. Dumping or disposal of excavated or demolition materials on Owner's property shall not be permitted. The Contractor shall remove and legally dispose of excavated or demolished materials off the Owner's property.

g. Care of Project Work Site: The contractor shall be responsible for maintaining the construction site in a reasonably neat and orderly condition by regular cleaning and mowing of the premises as determined by the Owner's Representative.

h. Discharge to Sewer Request: The University of Missouri's MS4 permit and NPDES Storm Water Discharge Permits along with the City of Columbia's POTW Operating Permit as well as local ordinances, and state and federal environmental regulations prohibit hazardous materials from being disposed into either the storm water or sanitary sewer systems. Unless specifically approved, all chemical products such as paints, dyes, lawn care products, maintenance products, and oil ~~is~~ are prohibited from drain disposal. Any product, including contaminated water, being discarded into the storm water or sanitary sewer systems requires written approval from the Owner through a formal "Discharge to Sewer Request" form obtained at Discharge to Sewer Request Form. The contractor should submit the form to the Owner's Representative, not to the Department of Environmental Health and Safety as the form indicates.

j. All concrete waste material including washout water shall be totally contained and removed from the Owner's property.

k. Artifacts Found During Construction: Contractor shall immediately notify the Owner's Representative when artifacts are uncovered or found during the demolition or construction process. Artifacts include, but are not limited to, tools, drawings (construction or other), photographs, books and other objects/devices which may hold historical importance/significance. Do not remove or disturb the object(s) in question. Artifacts are not considered part of demolished materials and shall remain the property of the University of Missouri.

l. **"Permit Required Confined Space" Entry Communication and Coordination**
(See OSHA 1926 subpart aa – Construction Confined Space for the definition of "permit required confined spaces" - Note: OSHA does not apply to the University. However, the University will provide a list of all known "permit required confined spaces")

The following are the known locations of "permit required confined spaces" currently identified withing the project limits:

i. Sanitary Waste Holding Tanks
ii. Storm Sewer Structures

The hazards or potential hazards in each "permit required confined space" or the reason it is a "permit required confined space":

(1) Air quality, elevated temperatures, access / egress
(2) Steam, heat, electricity, atmosphere.

Any precautions that the owner or previous contractors have implemented for the protection of employees in the "permit required controlled space":

(1) Air quality monitor, ventilation, gas detector, proper personal protective equipment, and confined space permit.

The above list of known confined spaces withing the project limits may not be a complete listing.

The Contractor shall notify the Owner's Representative if 1) conditions change resulting in a non-permit required confined space being reclassified to a "permit required confined space" after evaluation of the space by a competent person; 2) a space previously thought to be non-permit required space is classified as a "permit required confined space"; or 3) during the course of construction a "permit required confined space" is created after evaluation by a competent person.

The Contractor shall submit to the Owner's Representative a copy of the cancelled confined space entry permit and a written report summarizing the permit space program followed and all hazards confronted or created during entry operations. This information shall be submitted within one week of cancelling the permit.

m. Contractors and Subcontractors shall not have access within 10'-0" of the existing Middlebush building if they have been in contact with or proximity to swine, swine carcasses, animal diagnostic laboratories, and veterinary facilities within 48 hours of arrival to the construction site.

n. Contractors and Subcontractors requiring access to shower-in areas of the existing Middlebush building must follow the shower-in and wipe down policies as defined by

Middlebush Farm. Escorted access by Middlebush representatives will be required for shower-in areas.

9. PROTECTION OF OWNER'S PROPERTY

a. The Contractor shall be responsible for repair of damage to building exterior and interior, drives, curbs, streets, walks, grass, shrubbery and trees, which was caused by workmen or equipment employed during progress of work. All such repairs shall be made to satisfaction of the Owner's Representative, at no cost to the Owner, or reimburse the Owner if the Owner elects to make repairs. For landscape damage, the Owner shall make such repairs. Compensation for these repairs shall be determined by the Owner's Representative using the "Valuation of Landscape Trees, Shrubs, and other Plants" as published by the International Society of Arboriculture, as last revised.

b. Construction Project Fencing:

(1) Fencing requirements, as indicated on Drawings, shall be constructed of 9 or 11-gauge chain link not less than six (6) feet in height and not more than 2-inch mesh with posts spaced not more than ten (10) feet apart and all corner and gate posts imbedded in concrete. All other posts shall be sufficiently secured in ground to maintain proper and adequate support of fence. Fenced in area shall have at least two (2) access gates and all gates shall be lockable.

(2) Using existing landmarks, lamp posts, trees or other Owner property for support of fencing is strictly prohibited unless a written waiver is obtained from Owner's Representative.

(3) Use of ribbon, snow fence, chicken wire, rope, and wooden barricades as fencing is prohibited.

(4) Fencing shall be maintained in an "as-installed" condition throughout the life of the project.

(5) The Contractor may use used fencing provided it is in good condition and is satisfactory to the Owner's Representative.

c. Preserving and Protecting Existing Vegetation:

(1) Protection and compensation for damages:

(a) Trees and shrubs within work area designated to remain shall be protected from damage during construction by fixed chain link fencing or armoring as indicated on Drawings or specified herein. Plant protection devices shall be installed before work has begun and shall be maintained for duration of work unless otherwise directed by Owner's Representative.

(b) In the event that damage(s) to the Owner's trees, shrubs or vegetation occurs as a result of the Contractor's unauthorized operations, the Contractor shall pay or allow to the Owner compensation for said damage(s). Compensation shall be determined by the Owner's Representative using the "Valuation of Landscape Trees, Shrubs, and other Plants" as published by the International Society of Arboriculture, as last revised.

(2) Plants within work area designated for removal shall be removed by Contractor.

(3) To prevent compaction of soil over tree roots, vehicles or equipment shall not at any time park or travel over, nor shall any materials be stored within drip line of

trees designated to remain.

(4) Owner's Representative will stop work immediately when proper measures are not being employed to protect trees and shrubs. Contractor will be notified to resume work after required protection measures are implemented.

(5) Pruning of limbs necessary to repair damage or provide clearance for work shall be done by the MU Landscape Services Department at the direction of the Owner's Representative. Limbs shall be cut off cleanly and cut surfaces treated according to established horticultural standards.

10. SUBSTITUTIONS and EQUALS

a. Substitutions are defined in General Conditions article 3.11.8 and Equals are defined in General Conditions Article 3.12 .

b. Use of materials, products or equipment other than those named and described in the Contract Documents are substitutions and/or equal. Substitutions and/or equals submitted during the bidding period shall be received by both the Architect and the Owner at least ten calendar days prior to the date for receipt of bids. To be considered, bidder's proposal shall include a complete description of the proposed substitution and/or equal and a comparison of significant qualities of the proposed substitution and/or equal with those specified including drawings, performance and test data, and other information necessary for an evaluation. The Architect's decision on the approval or disapproval of a proposed substitution and/or equal shall be final.

c. If the Architect and Owner approve a proposed substitution prior to receipt of Bids, such approval will be set forth in an Addendum. Bidders shall not rely upon approval made in any other manner.

c. No substitutions and/or equal will be allowed for the following items:

Item	Specification Section
Lock Cylinders - Best	08 71 00
Control System – Johnson Controls	23 09 00
Fire Alarm Systems - FCI	28 31 11

11. CODES AND STANDARDS

The Contractor shall comply with applicable codes and standards as listed in General Conditions. The following codes and standards shall also apply:

a. City of Columbia - Sewer Line Installation Standards - Department of Public Works

"All sanitary sewer construction shall be in accordance with the City of Columbia Specifications and Standards and in conformance with the rules and regulations of the Missouri Clean Water Commission."

12. PERMITS

a. Permits and inspection for work UM property are required.
b. The owners Representative shall secure University Authority Having Jurisdiction building permits required for the project and shall provide a list of required inspection to the Contractor.
   (1) The contractor shall coordinate and provide reasonable scheduling and access to the Work for the Owner's Inspection.
   (2) Re-inspection of work as a result of either failed inspection or work not ready as scheduled may be at the Contractor's expense.

c. The Contractor shall comply with applicable codes and standards as listed in the Contract

Documents and General Conditions.

d. All permits, including, but not limited to Hot Work, Fire Alarm, Energized Work and HVAC interruption shall be coordinated and scheduled with the Owner's Representative or designee prior to commencement of the work.

e. Permits for Boilers, Water Heaters and Pressure Vessels require an installation permit from the State of Missouri. Before commencement of Boilers, Water Heaters or Pressure Vessels the Contractor must obtain an installation permit from the State of Missouri, Division of Fire Safety, Boiler and Pressure Unit as required by 11 CSR 40-2.010 through 11 CSR 40-2.065. The permit applications are available at http://www.dfs.dps.mo.gov/programs/bpv/ .

13. SPECIALTIES – NOT USED

14. PRE-BID INSPECTION

All pre-bid inspections of work areas shall be scheduled with pre-bid inspection guide, telephone: (573) 882-2228.

15. ROOF WARRANTY REQUIREMENT

a. The Contractor shall submit, before the first progress payment, a copy of University of Missouri Roof System Manufacturer's Certification, which shall be manually signed by an authorized representative of Manufacturer of each proposed roofing system. Certification shall have original signature.

b. Following final inspection and acceptance of the roofing system(s) by the Owner and the roofing system manufacturer(s), the Contractor shall submit a manually signed standard warranty agreement provided and executed by the roofing system manufacturer for each roofing system provided.

c. University of Missouri three (3) year Contractor's Roofing/Flashing/ Sheetmetal Guarantee shall be signed by the roofing contractor after final inspection and acceptance of each roofing system by Manufacturer and by Owner.

d. The Roofing contractor or subcontractor shall provide the Owner with an Application for a Roof Warranty.

16. MODIFICATIONS TO INFORMATION TO BIDDERS

a. Information to Bidders:

(1) Referenced Information to Bidders, Page IFB/5.
Add new Article 15.8.5 as follows:

15.8.5 Within 48 hours of the receipt of bids, the apparent low bidder shall submit to the Director of Facilities Planning and Development an "Affidavit of Supplier Diversity Participation" for every diverse subcontractor or supplier the bidder intends to award work to on the contract. The affidavit will be signed by both the bidder and the diverse firm.

17. MODIFICATION TO INFORMATION FOR BIDDERS: BIDDERS STATEMENT OF QUALIFICATIONS

a. Information For Bidders

(1) Reference: Information for Bidders, Article 8.4

Insert new Article 8.4 to read as follows:

In addition to the Bidder's Statement of Qualifications, the Bidder must also submit evidence and meet the following qualifications:

The project requires the services of a prime contractor who has demonstrated success in completing process/power plant work in an operating plant environment with little or no interruption of plant operations.

(a) MINIMUM QUALIFICATIONS

(i) Successful completion of one project of similar type and scope.

(ii) Successful completion of at least three projects of $15-million or greater value. Submit references for the three most recent projects over $15-million in value.

(iii) Electrical Contractor must have extensive experience installing 13.8-kV equipment and cable.

(iv) Successful and sustained track record of effectively utilizing project/schedule management software for at least the last two years.

(b) QUALIFICATION SUBMITTALS

(i) Submitted qualification packages should include the following information:

- Project and Schedule
  - Management Experience managing projects with equal or greater schedule demands.
  - Demonstrated and consistent on-time completion success
- Project Organization / Personnel
  - Key project team members and their resume
  - Project team roles and responsibilities of team members
  - Reporting/accountability procedures
  - Quality control program and procedures
- Organizational Support
  - Home office support
  - Labor and subcontractor relations
  - Submittal processing procedures
  - Material ordering/tracking/delivery Procedures
  - Cost accounting support
  - Financial stability/capacity
  - Record of mentoring and supporting Supplier Diversity Subcontractor Participation

(ii) Packages must include the following items:

- Corporate Organizational Charts
- Project Organizational Charts
- Summary of Similar Projects
- Client References
- Resumes – resumes for each key individual proposed for the project, include: position in the firm, project responsibility, education, license or registration and relevant experience over the

last five years.
- Financial Statements and/or Evidence of Bonding Capacity
- Sample progress reports and schedules
- Brief Narratives indicating how the Contractor intends to manage this project, including subcontractors.

(c) QUALIFICATION PROCEDURE

(i) All qualification information and supporting materials must be submitted with your bid. Following the bid date, the Owner reserves the right to request additional information material to evaluate qualifications. Failure of the Contractor to demonstrate their ability to comply with these qualifications may be grounds for the Owner not recommending aware of the Contract.

18. MODIFICATIONS TO GENERAL CONDITIONS – NOT USED

19. PROJECT SCHEDULING

The project scheduling specifications for the project are included immediately after the Special Conditions. For this project the Contractor shall meet the following scheduling requirements.

Option 3: Contractor Schedule – Contractor is responsible for the schedule and he may provide with in-house personnel or hire a third-party scheduling consultant. See Contractor Schedule Specification included in these documents.

20. PROJECT COORDINATION

a. Coordinate construction operations included in various Sections of these Specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections that depend on each other for proper installation, connection, and operation.

(1) Schedule construction operations in the sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

(2) Coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.

(3) Make provisions to accommodate items scheduled for later installation.

b. Coordination Drawings: Within sixty (60) days of Notice to Proceed provide coordination drawings for the integration of the Work, including work first shown in detail on shop drawings or product data. Show sequencing and relationship of separate units of work which must interface in a restricted manner to fit in the space provided, or function as indicated.

(1) Show the interrelationship of components shown on separate shop drawings.

(2) Indicate required installation sequences.

(3) Call attention in advance to Architect of any dimensional or detail information needed to complete the coordination drawings.

21. PROJECT PARTNERING – NOT USED

22. VALUE ENGINEERING – NOT USED

23. BUILDING QUALITY ASSURANCE

a. Contractor shall provide all personnel and equipment required to complete the Quality Assurance activities referenced in the Quality Assurance Log. The requirements of the Quality Assurance plan shall be completed in their entirety before substantial completion and submitted as referenced in the Closeout Log.

b. The contractor shall designate a competent person, separate from the superintendent or Project Manager, to act as the contractor's Quality Assurance coordinator. The Quality Assurance coordinator is responsible for planning, scheduling, coordinating, conducting and verifying all Quality Assurance activities required by the Quality Assurance plan and ensuring all building systems are complete, operable and ready for use by the Owner. At a minimum, building ventilation systems, chilled/hot water generation systems, hydronic distribution systems, power distributions systems and fire detection and alarm systems, as applicable.

24. MECHANICAL, ELECTRICAL, PLUMBING (MEP) PRE-INSTALLATION MEETING(S)

a. Before the start of MEP installation, the Owner's Representative will convene an MEP pre-installation meeting. Meeting participants to include contractor (including MEP subcontractors), Owner's Representative and additional contractor and University operational staff invited by the Owner's Representative. Topics will include underground rough-ins, steam piping, chilled water piping, sprinkler piping, hot water piping, electrical system, duct, telephone/data wiring, control wiring. Additional meetings will be conducted as required for the review of coordination drawings and scope specific installations. Cross section drawings of corridor ceilings and other congested areas will be of highest priority and will be reviewed prior to the start of installations in the affected areas. Meeting minutes and sign-up sheet will be transcribed by contractor and distributed to attendees.

25. COST BREAKOUT FOR OWNER'S ACCOUNTING PURPOSES – NOT USED

26. PROJECT MANAGEMENT/COMMUNICATION REQUIREMENTS

a. The Contractor shall be represented at the site by both a competent full-time Project Manager and a full-time, competent superintendent with no other assigned duties or responsibilities from the beginning of the work until its final acceptance, unless otherwise permitted by the Owner's Representative. The superintendent for the Contractor for the general building work shall exercise general supervision over all subcontractors of any tier engaged on the work with decision-making authority of the Contractor.

b. The Contractor shall use a current industry standard (Primavera, Microsoft Project, etc.) project scheduling software which provides as a minimum: Critical paths, milestones, estimated and actual start and completion dates, scheduled vs. actual progress, and detailed task and subtask breakdown. The following schedules shall be provided as a minimum and kept current: Overall project schedule, four- (4-) week look-ahead, and two- (2-) week look-ahead.

c. The Contractor shall furnish on-site Internet access for use by his Project Manager and superintendent. The University is providing an on-line, secure project communications web site which will be used as a major method of communicating and storing project information. This web site will be used to communicate directed and group email, RFIs,

change order requests and authorizations, and general correspondence. It will serve as a project message board, file storage and retrieval system, and will provide access to and storage of digital photos and contract documents and revisions.

d. The Contractor shall provide the on-site superintendent with a handheld cellular telephone.

27. SAFETY PRECAUTIONS AND PROGRAMS

a. The Bidder's Statement of Qualifications includes a requirement that the Bidder provide its Worker's Compensation Experience Modification Rates (EMR) and Incidence Rates for the three recent years. The Bidder shall also include the EMR and Incidence Rates of listed major subcontractors on the Bid for Lump Sum Contract. If the EMR exceeds 1 or the Incidence Rate exceeds 13, the Contractor or major subcontractor shall take additional safety measures including, but not limited to, developing a site-specific safety plan and assigning a Safety Manager to the Project to perform inspections on a schedule as determined acceptable by the Owner with written reports to be submitted to the Owner. The Owner reserves the right to reject a Bidder or major subcontractor whose rates exceed these stated rates.

b. The contractor shall provide Emergency Contact Information for the Contractor's on-site staff and home office management as well as contact information for all major subcontractor personnel. This information shall contain business and personal phone numbers for each individual for contact during or after hours in case of an emergency. This information shall be submitted within 15 days of the Notice to Proceed.

28. HOT WORK PERMITTING AND GENERAL REQUIREMENTS

Hot work Requirements: The contractor shall comply with the following hot work requirements and the requirements of the International Fire Code and 2014 NFPA 51B.

a. Hot work shall be defined as any work involving burning, welding, grinding, cutting, or similar operations that are capable of initiating fires or explosions.

a. The Contractor shall utilize the hot work permit decision tree and permit provided in the 2014 NFPA 51B for all Hot Work operations.

b. A hot work permit shall be used on all hot work performed outside a designated hot work area. The hot work permit shall be posted and clearly visible within proximity of the hot work area. The hot work permit authorizing individual (PAI) shall be as designated by the Contractor.

c. Notify the Owner's Representative 24 hours prior to starting hot work in buildings with operational fire alarm or fire suppression systems. The Owner's Representative will coordinate the appropriate system outage with Campus Maintenance personnel.

d. Unless otherwise instructed by the Owner's Representative, the Contractor shall post a copy of each completed hot work permit to the Owner's project management file system the following business day.

29. GENERAL REQUIREMENTS FOR CRANE AND HOISTING OPERATIONS

All crane and hoisting operations shall be performed in compliance with OSHA 29 CFR 1926. All Operators, riggers, and signal persons must have the proper qualifications and training necessary to perform the intended hoisting activities for this project.

a. Only fully certified and evaluated Operators shall perform equipment operations. Operators in an

"Operator in Training" status shall not be used.

b. Submittal requirements:

1. Submit copies of Operator certifications, licenses, and evaluations to the Owners Representative.

2. Submit Rigger and Signal Person qualifications to the Owners Representative.

3. Unless otherwise directed by the Owners Representative, submit a lift plan and conduct a lift coordination meeting for hoisting or crane operations for any lift greater than 2,000 pounds, or for any multi pick lift. Include protective measures for existing underground utilities, occupied buildings, pedestrian and vehicle pathways, adjacent buildings and overhead power lines. If the lift is to occur over an occupied building, provide a registered structural engineer's review and verification that the building can resist the impact of a dropped load for the intended lift. If evacuation of an occupied building is necessary to conduct the lift, the decision for building evacuation or scheduling the lift for off-hours will be determined by the Owner.

30. CONSTRUCTION WASTE MANAGEMENT

The goal of Construction Waste Management is to divert waste from the sanitary landfill. This shall be accomplished through reuse, recycling and/or salvage of non-hazardous construction and demolition debris to the greatest extent practical. Track and report all efforts related to reuse, recycling and/or salvage materials from the project (including clean fill material). Report all material types and weights, where material was diverted, type of diversion, documentation of diversion (eg: waste or recycling tickets), and applicable dates. In order to calculate the diversion percentage, total weights of all non-hazardous landfill material must be reported. This information shall be updated monthly utilizing the Construction Waste Management Worksheet provided here: http://www.cf.missouri.edu/cf/pdc/contractor_information. Copies of all applicable receipts, tickets and tracking logs shall be uploaded to the Owner's information sharing website or reported as required by the Construction Project Manager.

(A summary worksheet is required prior to substantial completion).

31. WARRANTY WALKTHROUGH

Contractor shall attend a walk-thru with the Owner at 11 months after acceptance to review and document any warranty items to be addressed as part of the 12 month warranty stated in article 3.1 of the General Conditions.

END OF SECTION

Option #3 – Contractor Schedule

1. GENERAL
   a) Time is of the essence for this contract.
      The time frames spelled out in this contract are essential to the success of this project. The University understands that effective schedule management, in accordance with the General Conditions and these Special Conditions is necessary to insure to that the critical milestone and end dates spelled out in the contract are achieved.
   b) Related Documents
      Drawings and general provisions of the Contract, including General Conditions' Article 3.17 shall apply to this Section.
   c) Stakeholders
      A Stakeholder is anyone with a stake in the outcome of the Project, including the University, the University Department utilizing the facility, the Design Professionals, the Contractor and subcontractors.
   d) Weather
      (1) Contractor acknowledges that there will be days in which work cannot be completed due to the weather, and that a certain number of these lost days are to be expected under normal weather conditions in Missouri.
      (2) Rather than speculate as to what comprises "normal" weather at the location of the project, Contractor agrees that it will assume a total of 44 lost days due to weather over the course of a calendar year, and include same in its as planned schedule. For projects of less than a calendar year, lost weather days should be prorated for the months of construction in accordance with the following schedule.
      (3) Anticipated weather days for allocation/proration only. For projects lasting 12 months or longer, the 44 days per year plus whatever additional months are included will constitute normal weather.

Jan – 5 days	Feb – 5 days	Mar – 4 days	Apr – 4 days
May – 3 days	Jun – 3 days	Jul – 2 days	Aug – 2 days
Sep – 3 days	Oct – 4 days	Nov – 4 days	Dec – 5 days

2. SCHEDULING PROCESS
   a) The intent of this section is to ensure that a well-conceived plan, that addresses the milestone and completion dates spelled out in these documents, is developed with input from all stakeholders in the project. Input is limited to all reasonable requests that are consistent with the requirements of the contract documents, and do not prejudice the Contractor's ability to perform its work consistent with the contract documents.
      Further, the plan must be documented in an understandable format that allows for each stakeholder in the project to understand the plan for the construction and/or renovation contained in the Project.

   b) Contractor Requirements
      (1) Schedule Development
          Contractor shall prepare the Project Schedule using Primavera P3 or Oracle P6.
      (2) Schedule Development
          Within 4 weeks of the NTP, contractor shall prepare a schedule, in CPM format, that reflects the contractor's and each subcontractor's plan for performing the contract work.

          Contractor shall review each major subcontractor's schedule with the sub and obtain the subcontractor's concurrence with the schedule, prior to submitting to the University.
      (3) Schedule Updates.
          (a) Schedule Updates will be conducted once a month, at a minimum.
              Actual Start and Finish dates should be recorded regularly during the month. Percent Complete, or Remaining Duration shall be updated as of the data date, just prior to Contractor's submittal of the update data.

(b) Contractor will copy the previous months schedule and will input update information into the new monthly update version.
(c) Contractor will meet with the Owner's Representative to review the draft of the updated schedule. At this meeting, Owner's Representative and Contractor will:
(i) Review out of sequence progress, making adjustments as necessary,
(ii) Add any fragnets necessary to describe changes or other impacts to the project schedule and
(iii) Review the resultant critical and near critical paths to determine any impact of the occurrences encountered over the last month.

(4) Schedule Narrative
After finalization of the update, the Contractor will prepare a Narrative that describes progress for the month, impacts to the schedule and an assessment as to the Contractor's entitlement to a time extension for occurrences beyond its control during the month and submit in accordance with this Section.

(5) Progress Meetings
(a) Review the updated schedule at each monthly progress meeting. Payments to the Contractor may be suspended if the progress schedule is not adequately updated to reflect actual conditions.
(b) Submit progress schedules to subcontractors to permit coordinating their progress schedules to the general construction work. Include 4 week look ahead schedules to allow subs to focus on critical upcoming work.

3. CRITICAL PATH METHOD (CPM)
a) This Section includes administrative and procedural requirements for the critical path method (CPM) of scheduling and reporting progress of the Work.
b) Refer to the General and Special Conditions and the Agreement for definitions and specific dates of Contract Time.
c) Critical Path Method (CPM): A method of planning and scheduling a construction project where activities are arranged based on activity relationships and network calculations determine when activities can be performed and the critical path of the Project.
d) Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall project duration.
e) Network Diagram: A graphic diagram of a network schedule, showing the activities and activity relationships.
f) Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling, the construction project. Activities included in a construction schedule consume time and resources.
g) Critical activities are activities on the critical path.
h) Predecessor activity is an activity that must be completed before a given activity can be started.
i) Milestone: A key or critical point in time for reference or measurement.
j) Float or Slack Time: The measure of leeway in activity performance. Accumulative float time is not for the exclusive use or benefit of the Owner or Contractor, but is a project resource available to both parties as needed to meet contract milestones and the completion date.
k) Total float is herein defined as the measure of leeway in starting or completing an activity without adversely affecting the planned project completion date.
l) Weather: Adverse weather that is normal for the area must be taken into account in the Contractor's Project Schedule. See 1.d.3, above.
m) Force Majeure Event: Any event that delays the project but is beyond the control and/or contractual responsibility of either party.
n) Schedule shall including the following, in addition to Contractor's work.
(1) Phasing: Provide notations on the schedule to show how the sequence of the Work is affected by the following:
(a) Requirements for phased completion and milestone dates.
(b) Work by separate contractors.
(c) Work by the Owner.

(d) Coordination with existing construction.
(e) Limitations of continued occupancies.
(f) Uninterruptible services.
(g) Partial occupancy prior to Substantial Completion.
(h) Area Separations: Use Activity Codes to identify each major area of construction for each major portion of the Work. For the purposes of this Article, a "major area" is a story of construction, a separate building, or a similar significant construction element.

4. TIME EXTENSION REQUESTS
   a) Refer to General Conditions of the Contract for Construction, Article 4.7 Claims for Additional Time.
   b) Changes or Other Impacts to the Contractor's Work Plan
      The Owner will consider and evaluate requests for time extensions due to changes or other events beyond the control of the Contractor on a monthly basis only, with the submission of the Contractor's updated schedule, in conjunction with the monthly application for payment. The Update must include:
      (1) An activity depicting the event(s) impacting the Contractors work plan shall be added to the CPM schedule, using the actual start date of the impact, along with actually required predecessors and successors.
      (2) After the addition of the impact activity(ies), the Contractor will identify subsequent activities on the critical path, with finish to start relationships that can be realistically adjusted to overlap using good, standard construction practice.
         (a) If the adjustments above result in the completion date being brought back within the contract time period, no adjustment will be made in the contract time.
         (b) If the adjustments above still result in a completion date beyond the contract completion date, the delay shall be deemed excusable and the contract completion date shall be extended by the number of days indicated by the analysis.
         (c) Contractor agrees to continue to utilize its best efforts to make up the time caused by the delays. However, the Contractor is not expected to expend costs not contemplated in its contract, in making those efforts.

   c) Questions of compensability of any delays shall be held until the actual completion of the project. If the actual substantial completion date of the project based on excusable delays, excluding weather delays, exceeds the original contract completion date, AND there are no delays that are the responsibility of the contractor to consider, the delays days shall be considered compensable. The actual costs, if any, of the Contractor's time sensitive jobsite supervision and general conditions costs, shall be quantified and a change order issued for these costs.

THIS PAGE INTENTIONALLY LEFT BLANK

UNIVERSITY OF MISSOURI
ROOF SYSTEM MANUFACTURERS CERTIFICATION
(Revised 12/94)

TO:_____Title_____
Project No. _____
Location _____

Our technical staff has examined the Architect/Engineer's Drawings, Specifications and required warranty for the roofing work on this project. We do not wholly endorse the building design or any materials or services not part of our advertised roofing system.

CERTIFICATION

We hereby certify that:

1. All materials we will furnish and deliver to the project shall be of good merchantable quality, shall meet or exceed the Specifications required and shall, if properly applied by one of our approved roofing applicator firms in accord with our instructions, provide a sound weather/watertight roofing system.
2. Upon completion of the installation in accord with the Drawings and specifications and our recommended installation procedures, we shall issue a total system warranty specified in the project Specifications.
3. The Drawings and Specifications follow the recommendations of our roofing manual for this type of roofing system with:

   No exceptions.

   The following exceptions: (The roofing system will be approved for this project if the following changes are made to the Contract Documents. The bid provided with this Document includes the required changes).

   NOTE: Exceptions may cause Owner to reject bid.
   Exceptions are as follows:

_____
_____
_____
_____
_____
_____

4. The Warranty will be issued for the following proposed roofing system:

_____
_____
_____

ROOFING SYSTEM MANUFACTURER: _____

Authorized Signature: _____

Title: _____Date _____

Telephone Number: ( )_____

Fax Number: ( )_____

THIS PAGE INTENTIONALLY LEFT BLANK

UNIVERSITY OF MISSOURI
CONTRACTORS ROOFING/FLASHING/SHEET METAL GUARANTEE
(Revised 12/94)

WHEREAS (NAME AND ADDRESS OF COMPANY)_____
herein referred to as Roofing Contractor, certify that they have furnished and installed all roofing, flashing, sheet metal and related components in accordance with the Contract Documents and as required by the Roofing System Manufacturer=s installation instructions on the facility described below:

Facility: _____

Owner: University of Missouri-(CAMPUS)
(CAMPUS ADDRESS)

Date of Full Completion: _____

Approximate Area of Roof: _____

Type of Roofing Material: _____

Manufacturer's Specification Number: _____

Thickness and Type of Roof Insulation: _____

NOW, THEREFORE, Roofing Contractor guaranties to the Owner, subject only to the exclusions stated hereinafter, that all roofing, flashing and sheet metal work is fully and integrally watertight and is free from faults and defects in material or workmanship, and is guaranteed for a period of three (3) years from date of full completion of work.

EXCLUSIONS: This guarantee does not cover, and Roofing Contractor shall not be liable for the following:

1. Damage to the roofing system caused by fire, lightning, tornado, hurricane or hailstorm.

2. Damage to roofing system caused by significant settlement, distortion or failure of roof deck, walls, or foundations of building, excepting normal building expansion and contraction is not a part of this exclusion.

3. Abuse by the Owner and/or third parties.

REPAIRS: Owner shall promptly notify Roofing Contractor, in writing, of the need for repair of roofing, flashing, or sheet metal:

1. Roofing Contractor, within eight (8) hours after receipt of such notice, shall make emergency repairs at its expense, as required to render the facility watertight.

2. Within five (5) days after receipt of such notice, Roofing Contractor shall at its expense correct any faults or defects in material or workmanship.

3. Should needed repairs not be covered by this guarantee, Roofing Contractor, after having obtained Owner's written consent, shall make such repairs at Owner's expense. Following said repairs, this guarantee shall thereafter remain in effect for the unexpired portion of the original term. If Owner does not so consent or repairs are made by others than the Roofing Contractor, this guarantee shall terminate for those parts of the roof affected by the repair.

4. In the event that Owner has notified the Roofing Contractor of the need for repairs and (i) Roofing Contractor does not immediately make repairs, or (ii) Roofing Contractor disclaims responsibility

for the repairs and Owner disagrees, or (iii) Owner considers Roofing Contractor=s quoted cost for repairs not covered by this guarantee to be unreasonable and, an emergency condition exists which requires prompt repair to avoid substantial damage or loss to Owner, then, Owner may make such temporary repairs as he finds necessary and such action shall not be a breach of the provisions of this guarantee.

ANNUAL INSPECTIONS: Roofing Contractor shall inspect roof installation prior to each of the three anniversary dates from date of full completion of the work.

1. Inspection team to include Roofing Contractor, Roof Manufacturer, and Owner=s Representative.

2. Inspection of total roof system will be included in the annual inspections.

3. All defects in total roof system will be corrected by the Roofing Contractor within 30 days of inspection.

4. Roof manufacturer will certify by a written report that roof inspection has been completed, defects are acknowledged, and will warrant any repairs.

5. All corrective work completed by Roofing Contractor shall be warranted as approved by the Roofing Manufacturer.

ROOF MODIFICATION: Should Owner require work to be done on roof of said facility including modifications, alternations, extensions or additions to roof and including installation of vents, platforms, equipment, bracings or fastenings, Owner shall notify Roofing Contractor and give Roofing Contractor an opportunity to make recommendations as to methods necessary to safeguard against damage to roofing covered by this guarantee. Failure of Owner to give Roofing Contractor such opportunity or failure to follow methods recommended by Roofing Contractor shall render this guarantee null and void to the extent such failure should result in damage to roofing covered by this guarantee.

NOTICES: Notification of Roofing Contractor by Owner, shall be fulfilled by sending notice to Roofing Contractor.

IN WITNESS WHEREOF, we set our hands this _____ day of _____, 20___.

By:_____

Title:_____

For Roofing Contractor

Name:_____

Address:_____

Phone:_____

SHOP DRAWING AND SUBMITTAL LOG

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd2	Cont'r	Copies To	File
024119	Proposed protection measures; Schedule of selective demolition; Pre-demolition photos										
031000	Product Data; Field Reports										
032000	Product Data, Shop Drawings										
033000	Product Data; Shop Drawing; Qualification Data; Material Certificates; Test Reports; Quality Contol Reports; Vapor Barrier install documentation										
042200	Product data/Material certificates; Mix design;Statement of compressive strength; Weather proceedures										
054000	Product Data, Certificates, Shop Drawings, Delegated Design										
05500	Shop drawings; Qualification data										
72100	Product data; Samples; Product test and evaluation reports										
076200	Product data; Shop drawings; Samples;										
077253	Product data; Shop drawings										
079200	Product data; Samples; Product test reports; Sample warranties										
079500	Shop drawings; Samples; Product test reports										
081113	Product data; Shop drawings; Schedule; Product test reports;										
081613	Product data										
083113	Product data; Shop drawings										
084113	Product data; Shop drawings; Energy performance certificates; Product test reports; Sample warranties										
087100	Product data; Shop drawings; Hardware schedule										
088000	Product data; Samples										
092216	Product data										
092900	Product data										
093000	Product data; Samples										
096733	Product data; Samples; Test data; Installer's qualifications										
096813	Product data; Samples; Warranty sample										
099113	Product data; Samples; Product list										

SHOP DRAWING AND SUBMITTAL LOG

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd2	Cont'r	Copies To	File
099123	Product data; Samples										
099600	Product data; Samples										
102600	Product data; Shop drawings; Samples										
102800	Product data & schedule										
104413	Product data & schedule										
115319	Product data; Shop drawings; Sample warranty										
115320	Product data; Shop drawings; Sample warranty										
115353	Shop drawings; product data; manufacturer's qualifications; installer qualification										
123553	Shop drawings; Keying schedule; Samples; Mfr. Qualification data; Product test reports										
133419	Product data; Shop drawings; Samples; Qualifications data; Manufacturer accreditation and certificates; Systems certificates; Erector certificates; test reports; QC reports; Sample warranties										
210500-01	Shop Drawings										
210500-02	Coordination Drawings										
210500-03	Permits										
210500-04	Welding Certificates										
210500-05	Warranties										
210500-06	As-built Documents										
210500-07	Pipe Pressure Test Logs										
210500-08	O&Ms										
210500-09	Training Seminar										
210519-01	Product Data										
210529-01	Product Data										
210529-02	Mechanical Seals										
210529-03	Fire Sealants										
210553-01	Identification Materials										
210553-02	Valve Schedule										
211313-01	Product Data										
211313-02	Shop Drawings										
211313-03	Hydraulic Calculations										
211313-04	Hydraulic Test Reports										

SHOP DRAWING AND SUBMITTAL LOG

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd2	Cont'r	Copies To	File
220500-01	Plumbing Permits										
220500-02	Plumbing Licenses										
220500-03	EPA/ASHRAE 34 Refrigeration Certification										
220500-04	Welding Certificates										
220500-05	Warranties										
220500-06	As-built Documents										
220500-07	Pipe Pressure Test Logs										
220500-08	O&Ms										
220500-09	Close Out/ Walk through Documentation										
220500-10	Training Seminar Documentation										
220519-01	Flow Meters										
220519-02	Calibrated Balance Valves										
220519-03	Pressure Gauges										
220519-04	Thermomoeters										
220519-05	Pressure/ Temperature test plugs										
220519-06	Warranties										
220519-07	O&Ms										
220529-01	Product Data										
220529-02	Pipe Supports, Anchors, Sleeves, and Hangers										
220529-03	Equipment curbs, supports, and hangers										
220529-06	Fire Sealants										
220548-01	Vibration Controls										
220553-01	Plumbing Indentification Material										
220553-02	Valve Schedule										
220553-03	Record Documents										
220716-01	Equipment Insulation Materials										
220716-02	Insulation Schedule										
220719-01	Pipe Insulation Materials										
220719-02	Insulation Schedule										
220719-03	Project Record Documents										
221000-01	Piping Material and Schedule										
221000-02	Fitting Schedule										
221000-03	Valve Material										
221000-04	Valve Schedule										
221000-05	piping accessories										

SHOP DRAWING AND SUBMITTAL LOG

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd2	Cont'r	Copies To	File
221000-06	Hydrostatic test reports										
221000-07	Domestic water sample test reports										
221000-08	O&M Manuals										
221000-09	As-builts										
221119-01	Product Data										
221119-02	O&M Manuals										
221343-01	Product Data										
221343-02	Warranties										
222123-01	Product Data										
222123-02	Warranties										
223000-01	Product Data										
223000-02	Warranties										
223000-03	Start Up Service										
224000-01	Product Data										
224000-02	Product Accessories										
224000-03	O&Ms										
226700-01	Installer Factory Training and Certification										
226700-02	O&M Manuals										
226700-03	As-built valve locations										
226700-04	RO water piping material and fitting schedule										
226700-05	RO water valves										
226700-06	RO water pipe accessories										
226700-07	RO water hydrostatic test reports										
226701-01	Product Data										
226701-02	Warranty										
226701-03	O&Ms										
226701-04	Testing & start up										
230500-01	Welder Certificates										
230500-02	Coordination Drawings										
230500-03	Pipe Pressure Test Log										
230519-01	Product Data-Meters										
230519-02	Product Data-Sight Flow Indicators										
230519-03	Product Data-Gauges										
230519-04	Product Data-Thermometers										
230519-05	Product Data-Test Plugs										

SHOP DRAWING AND SUBMITTAL LOG

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd2	Cont'r	Copies To	File
230529-01	Product Data-Hangers and Supports										
230529-02	Product Data-Equipment Curbs										
230529-03	Product Data-Sleeves,sealants ans seals										
230529-04	Product Data-Pipe Stands										
230548-01	Product Data - Vibration Controls										
230553-01	Product Data/Schedule - Pipe/Duct Markers										
230553-02	Product Data - Equip Mark Nameplates										
230713-01	Product Data - Ductwork Insulation										
230713-02	Ductwork Insulation - Qualifications										
230713-03	Ductwork Insulation Schedule										
230716-01	Insulation and Accessories										
230716-02	HVAC Equipment Insulation Schedule										
230719-01	Product Data - Insulation and Accessories										
230719-02	HVAC Piping Insulation Schedule										
230900-01	Product Data - BAS System and Accessories										
230900-02	Product Data - Control Dampers										
230900-03	Product Data - Control Valves										
230900-04	Product Data - Acuators										
230900-05	Product Data - Sensors/Transmitters										
230900-06	Product Data - Control Wiring										
230900-07	Qualifications, Certificates, and Reports										
230900-08	Maintance Data										
230900-09	Wiring Diagram										
230900-10	Sequence of Operations										
232113-01	Product Data - Steel Piping, Fittings, and Joints										
232113-02	Product Data - Copper Tubing, Fittings, and Joints										
232113-03	Product Data - Dielectric Nipple										
232113-04	Product Data - Valves										
232113-05	Pipe/fittings/joints - Schedule										
232116-01	Product Data - Expansion tanks										

SHOP DRAWING AND SUBMITTAL LOG

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd2	Cont'r	Copies To	File
232116-02	Product Data - Air vents										
232116-03	Product Data - Air/Dirt separators										
232116-04	Product Data - Strainers										
232116-05	Product Data - Relief valves										
232116-06	Product Data - Flexible connections										
232116-07	Product Data - Chemical pot feeders										
232123-01	Product Data - Pumps and Fittings										
232123-02	Product Data - Qualifications										
233113-01	Product Data - Sheet Metal Materials										
233113-02	Product Data - Sealant and Gaskets										
233113-03	Product Data - Fasteners										
233113-04	Product Data - Insulated Flexible Ducts										
233113-05	Ductwork Schedule										
233113-06	CAD-Generated Shop Drawings										
233300-01	Product Data - Turning Vanes										
233300-02	Product Data - Duct access doors										
233300-03	Product Data - Duct test holes										
233300-04	Product Data - Flexible duct connections										
233300-08	Product Data - Manual balancing dampers										
233300-09	Product Data - Gravity backdraft dampers										
233300-11	Product Data - Remote damper operators										
233423-01	Product Data/Shop Drawings - Power Ventilators										
233423-02	Fan Curves/Sound Data/AMCA Rating Power Ventilators										
233600-01	Product Data - ATUs and Accessories										
233600-02	Unit Schedule										
233700-01	Product Data - Diffusers										
233700-02	Product Data - Registers/grilles										
235200-01	Product Data/Shop Drawings - Heating Boilers										
235200-02	Wiring Diagrams - Heating Boilers										
235200-03	Warranty Information- Heating Boilers										

SHOP DRAWING AND SUBMITTAL LOG

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd2	Cont'r	Copies To	File
237413-01	Product Data/Shop Drawings - Dedicated Outdoor Air Systems										
237413-02	Wiring Diagrams - Dedicated Outdoor Air Systems										
237313-03	Performance Data - Filters/Burner/Evaporator/Dampers/Heat Exchanger/Fans/Sound Power										
238126-01	Product Data, Shop Drawings - Split Systems										
238126-02	Manufacturer's Installation Instructions - Split Systems										
238126-03	Warranty - Split Systems										
238413-01	Product Data, Shop Drawings - Gas-to-Steam Humidifier										
238413-02	Manufacturer's Installation Instructions - Gas-to-Steam Humidifier										
238413-03	Product Data, Shop Drawings - Humidifier Dispersion Grid										
238413-04	Manufacturer's Installation Instructions - Humidifier Dispersion Grid										
238413-05	Warranty - Gas-to-Steam Humidifier										
260501	Product Data, Shop Drawings										
260519	Product Data, Shop Drawings										
260526	Product Data, Shop Drawings										
260533	Product Data, Shop Drawings										
260573	Shop Drawings										
262200	Product Data, Shop Drawings										
262413	Product Data, Shop Drawings, Warranty, Qualification Data, Field Quality-control Reports										
262416	Product Data, Shop Drawings, Warranty, Qualification Data, Field Quality-control Reports, Panelboard Schedules										
262550	Produt Data, Shop Drawings, Field Quality Control Reports										
262726	Product Data										
262913	Product Data, Shop Drawings										

SHOP DRAWING AND SUBMITTAL LOG

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd2	Cont'r	Copies To	File
262923	Product Data, Shop Drawings, Test Reports										
263213	Product Data, Spec. Compliance, Certs., Warranty, Shop Drawings, Wiring Diagrams,										
263623	Product Data, Shop Drawings, Wiring Diagrams, Test and Certifications, Warranty										
264100	Product Data, Shop Drawings										
265100	Product Data										
270000	Product Data, Shop Drawings										
283111	Product Data, Shop Drawings, Qualification Data - Installer										
285500	Test Reports										
312000	Product data										
312319	Product data										
316329	Product data; Mixtures; Shop drawings										
321216	Product data										
321313	Product data										
321373	Product data; Samples; Schedule										
321733	Product data; Shop drawings; Samples										
323136	Shop drawings; Certifications; Installer qualification data										
331100	Product data										
334100	Product data; Shop drawings										
334600	Product data; Samples										
334613	Product data; Samples										

SHOP DRAWING AND SUBMITTAL LOG

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd2	Cont'r	Copies To	File

THIS PAGE INTENTIONALLY LEFT BLANK

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Catalog Data	Wiring Diagrams	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions
081113	Hollow Metal Doors and Frames	x		x			
081113	Fiberglass-Reinforced Plastic Doors	x		x			
083113	Access Doors and Frames	x		x			
084113	Aluminum-Framed Storefronts	x					
088000	Glazing	x					
093000	Tile	x		x			
096813	Resinous Flooring	x		x			
096813	Tile Carpet	x		x			
102600	Wall Protection	x					
102800	Toilet and Bath Accessories	x					
104413	Fire Protection Cabinets	x					
115319	Dry Heat Sterilizer	x	x	x			x
115320	Steam Heat Sterilizer	x	x	x			x
115353	Biological Safety Cabinets	x		x			x
123553	Stainless Steel Laboratory Casework	x		x			
133419	Metal Building Systems	x		x			
210529	Fire Suppression Hangers and Supports	x					
210553	Pipe Markers	x					
211313	Valves	x					
211313	Sprinklers	x					
220529	Plumbing Hangers and Supports	x					
220553	Pipe Markers	x					
220716	Plumbing Equipment Insulation	x					
220719	Plumbing Piping Insulation	x					
221000	Valves	x		x	x		
221119	Backflow Preventers	x		x	x		x
221119	Expansion Tanks	x		x			x
221119	Cleanouts	x					
221119	Water Hammer Arrestors	x		x			
221343	Facility Packaged Sewage Pumping Stations	x	x	x	x	x	x
222123	Plumbing Pumps	x	x	x	x	x	x
223000	Water Heater	x	x	x	x		x
223000	Thermal Mixing Valve	x	x	x	x		x
224000	Plumbing Fixtures	x	x	x	x		x
226700	Reverse Osmosis Water Piping and Valves	x		x	x		
226701	Water Purification System	x	x	x	x	x	x

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Catalog Data	Wiring Diagrams	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions
230519	HVAC Meters and Gauges	x					
230529	HVAC Hangers and Supports	x					
230548	Vibration Isolators	x					
230553	Duct/Pipe Markers	x					
230713	Dcutwork Insulation	x					
230716	HVAC Equipment Insulation	x					
230719	HVAC Piping Insulation	x					
230900	EMCS Devices/Controllers	x	x	x	x		x
230900	Control Wiring	x					
230900	Control Valves / Dampers + Actuators	x	x	x	x		x
230900	Airflow/Temperature Measurement Devices	x	x	x	x		x
232113	Dielectric Nipple	x					
232113	Calibrated Balance Valves	x					x
232113	Ball Valves	x					
232113	Butterfly Valves	x					
232113	Check Valves	x					
232116	Expansion Tanks	x		x	x		
232116	Air/Dirt Separators	x		x	x		
232116	Strainers	x		x	x		
232116	Safety Relief Valves	x		x	x		
232116	Flexible Connections	x					
232116	Chemical Pot Feeders	x		x	x		x
232123	HVAC Pumps	x	x	x	x	x	x
233300	Ductwork Accessories	x		x	x		x
233423	HVAC Power Ventilators	x	x	x	x	x	x
233600	Air Terminal Units	x	x	x	x		x
233700	Air Outlets and Inlets	x					
235200	Heating Boilers	x	x	x	x	x	x
237413	Dedicated Outdoor Air Systems	x	x	x	x	x	x
238126	Split Systems	x	x	x	x		x
238413	Humidifiers	x	x	x	x		x
260500	Electrical General Provisions			X			X
260501	Basic Materials and Methods	X		X			
260519	Conductors	X					
260526	Grounding System	X		X			
260533	Raceways	X		X			

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Catalog Data	Wiring Diagrams	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions
260573	Low Voltage Electrical Systems Studies					x	
262200	Dry-Type Transformers	X	X	X			
262413	Switchboards	X	X	X	X		X
262416	Panelboards	X	X	X	X		X
262550	Dual Purpose Docking Station	X	X	X	X		X
262726	Wiring Devices	X		X			
262913	Motor Controllers	X	X	X			X
262923	Variable Frequency Drives	X	X	X			X
263213	Emergency Standby Power System Generator Set	X	X	X	X		X
263623	Automatic Transfer Switch	X	X	X	X		X
264100	Lightning Protection System	X					
265100	Lighting	X		X	X		
283111	Digital Addressable Fire Alarm System	X	X	X	X		X
285500	RF Survey for In-Building Two Way Emergency Responder Communication Enhancement System						

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Catalog Data	Wiring Diagrams	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor/Subcontractor	Date Received	# of Copies	Remarks
024119	SELECTIVE DEMOLITION: Non-disruction of existing warranty for existing building elements included in demolition				
076200	Sheet Metal Fabrications; Warranty information - 5 year finish, 3 year weathertightness.				
079200	Joint Sealants: Warranty information - 2 year installer, 5 year manufacturer				
084113	Hollow Metal Doors & Frames: Maintenance data; Warranty 5 years.				
081613	Fiberglass-Rienforced Polymer Doors; Lifetime Warrenty.				
087111	Door Hardware: Maintenance data; Warranty 3 year				
088000	Glazing: Warranty 10 year				
096733	Resinous Floor and Walls: Maintenance data, extra materials; Warranty 5 year				
099113	Exterior Paint: Maintenance data, extra materials				
099600	High-performance Coating: Maintenance data, extra materials				
115319	Dry Heat Sterilizer: Operation manuals; Service agreement; Warranty				
115320	Steam Heast Sterilizer: Warranty				
115353	Product operation and maintenance data, warranty data, start-up reports.				
123553	Lab Casework: Extra materials				
133419	Metal Building: Finishes maintenance manuals; Warranties 25 years				
210500	BASIC FIRE SUPPRESSION REQUIREMENTS: Pressue Test Log				
211313	FIRE SUPPRESSION SYSTEM: Maintenance Information, Pipe Pressure Test Log, Contractors Material and Test Certificate, Extra Materials, Hydraulic Calcs/Shop Drawings stamped by AHJ				
220500	BASIC PLUMBING REQUIREMENTS: Pressue Test Log				
221000	PLUMBING PIPING: Pipe Pressure Test Reports, Water disinfection test reports,,				
221119	PLUMBING SPECIALTIES: Maintenance information, Backflow Preventer Test Report				
221343	FACIILTY PACKAGED SEWAGE PUMPING STATIONS: Maintenance information, Extra materials, Installation/startup reports				
223000	PLUMBING EQUIPMENT: Installation/Startup Reports				
226700	REVERSE OSMOSIS WATER PIPING: Pipe Pressure Report, Owner Training				
226701	WATER PURIFICATION SYSTEM EQUIPMENT: Installation/Startup Reports, Sampling Reports				
230500	BASIC HVAC REQUIREMENTS: Pipe Pressure Logs				
230553	HVAC IDENTIFICATION: Record Documentation of Tagged Valves				
230519	HVAC METERS AND GAUGES: Maintenance information				

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor/Subcontractor	Date Received	# of Copies	Remarks
230900	DIGITAL CONTROLS EQUIPMENT: As-built Sequence of Ops, Controls diagrams framed and protected by glass, mounted next to controller				
232113	HYDRONIC PIPING: Extra materials, maintenance information, Pressure test reports				
232116	HYDRONIC SPECIALTIES: Maintenance data				
232123	HVAC PUMPS: Maintenance information, Extra Materials - (1) set of mech seals/gaskets for each pump				
233113	DUCTWORK: Pressure Test				
233300	DUCTWORK ACCESSORIES: Maintenance information				
233423	HVAC POWER VENTILATORS: Maintenance information, Installation reports				
233600	AIR TERMINAL UNITS: Maintenance information				
235200	HEATING BOILERS: Maintenance data, Warranty Information, Installation/Startup Reports, Product Demonstration/Owner Training				
237413	DEDICATED OUTDOOR AIR SYSTEMS: Maintenance data, Warranty Information, Startup Report				
238126	SPLIT SYSTEMS: Maintenance data, Warranty 5 year				
238413	HUMIDIFIERS: Maintenance data, Warranty 2 year, Start-up Letter, Owner Training				
260500	ELECTRICAL GENERAL PROVISIONS Electrical Test Reports and Motor Test Reports, Record Documents				
260501	BASICS MATERIALS AND METHODS Extra materials, Record Documents				
260533	RACEWAYS Record Documents				
262200	DRY TYPE TRANSFORMERS Record Documents				
262413	SWITCHBOARDS Record Documents, Warranty				
262416	PANELBOARDS Record Documents, Warranty				
262550	DUAL PURPOSE DOCKING STATION Record Documents, Warranty				
262726	WIRING DEVICES Record Documents				
262913	MOTOR CONTROLLERS Record Documents				
262923	VARIABLE-FREQUENCY MOTOR CONTROLLERS Test Reports, Extra Materials, Service/Maintenance Agreement, Record Documents				
263213	ELECTRICAL EMERGENCY STANDBY POWER SYSTEM GENERATOR SET Record Documents, Warranty, Service Agreement				

Project: Nextgen Center of Excellence for Influenza Research Phase II

Project Number: CP230831

Contractor:

Section	Description	Contractor/Subcontractor	Date Received	# of Copies	Remarks
263623	ELECTRICAL EMERGENCY STANDBY POWER SYSTEM GENERATOR SET Record Documents, Warranty, Service Agreement				
263623	AUTOMATIC TRANSFER SWITCH Record Documents, Warranty				
264100	LIGHTNING PROTECTION SYSTEM Record Documents, Warranty				
265100	LIGHTING Record Documents				
270000	TELECOMMUNICATIONS Record Documents				
283111	ADDRESSABLE FIRE ALARM SYSTEM Record Documents				
285500	RF SURVEY FOR IN-BUILDING TWO WAY EMERGENCY RESPONDER COMMUNICATION ENHANCEMENT SYSTEM Test Reports				
323113	Maintenance manual				

THIS PAGE INTENTIONALLY LEFT BLANK

Sustainability Report

Material Description	Ticket No.	Date	Material Type	Weight	Notes

Total weight of all demolition material: _____

Percentage of total material diverted: _____

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

CP230831 NextGen Influenza Research PhII Quality Assurance Check List

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
1						
Building System Commissioning						
Commissioning Agent - Conduct pre-installation meetings per specifications.					Meeting Minutes	☑
15713						
Temporary Erosion and Sediment Control						
Inspect at least once a week and after any rain event					Inspection Report	☑
24119						
Selective Demolition						
Return adjacent areas to condition existing before demolition operations began					Pre-construction video or digital photos	☑
32000						
Concrete Reinforcing						
Hold Preinstallation Conference as specified					Meeting Minutes	☑
Perform Field Quality Control section of specifications					Test Report	☑
33000						
Cast-In-Place Concrete						
Hold Preinstallation Conference as specified					Meeting Minutes	☑
Provide a Copy Of Field Cured Concrete Cylinder Test Report to Owner's Rep Prior to Stripping Any Load Bearing Formwork					Test Report From Independent Testing Lab	☑
Sampling and testing shall be done in accordance with contract documents						☐

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Submit concrete mix designs prepared by a qualified testing laboratory for approval prior to placement.					mix design reports	☐
42200						
Concrete Unit Masonry						
Hold Preinstallation Conference as specified					Meeting Minutes	☑
Perform Field Quality Control section of specifications					Test Report	☑
54000						
Cold-Formed Metal Framing						
Hold Preinstallation Conference as specified					Meeting Minutes	☑
Provide welder qualification report for each welder on site					Welder Qualifications	☑
55000						
Metal Fabrications						
Provide welder qualification report for each welder on site					Welder Qualifications	☑
79200						
Joint Sealants						
Clean out joints immediately before installing joint sealant						☑
87111						
Door Hardware						
Perform Demonstration and Training section of specifications					Sign-in Sheet	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Perform Field Quality Control section of specifications					Test Report	☑
Verify door closures comply with ADA requirements						☐
88000						
Glazing						
Wash clear glass on both faces not more than 4 days prior to punch list inspection						☐
92216						
Non-Structural Metal Framing						
Provide welder qualification report for each welder on site					Welder Certificates	☑
92900						
Gypsum Board						
Provide Protection as specified					Inspection Report	☑
93000						
Tile						
Provide Extra Material as specified					Transmittal	☑
96733						
Trowel-Applied Resinous Flooring and Wall Coating						
Build Mockup as specified					Inspection Report	☑
Conduct Pre-Installation Meetings					Meeting Minutes	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
96813						
Tile Carpeting						
Provide Extra Material as specified					Transmittal	☑
99113						
Exterior Painting						
Periodically Check Wet Film Thickness To Assure Conformance With Manufacturer's Requirements To Achieve Dry Film Thickness					field report	☑
Provide Extra Material as specified					Transmittal	☑
99123						
Interior Painting						
Periodically Check Wet Film Thickness To Assure Conformance With Manufacturer's Requirements To Achieve Dry Film Thickness					field report	☑
99600						
High-Performance Coatings						
Build Mockups as specified					Inspection Report	☑
Provide Extra Material as specified					Transmittal	☑
115320						
Steam Heat Sterilizer						
Hold Preinstallation meetings as specified					Meeting Minutes	☑
115519						
Dry Heat Sterilizer						
Perform Testing and Acceptance section of specifications					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
123553						
Stainless Steel Laboratory Casework						
Provide Extra Material as specified					Transmittal	☑
133419						
Metal Building Systems						
Hold Preinstallation Meetings as specified					Meeting Minutes	☑
Perform all testing required in specifications.					Test Report	☑
210500						
Basic Fire Suppression Requirements						
Perform Start-up section of specifications					NFPA13 Certification	☑
211313						
Fire Suppression System						
Flush, test and inspect sprinkler piping per Field Quality Control section of specifications					test report and NFPA 13	☑
Perform Identification Signs section of specifications					NFPA 13 Certification	☑
Provide Extra Material as specified					Transmittal	☑
220500						
Basic Plumbing Requirement						
Hold MEP pre-installation meeting(s).					Meeting Minutes and Sign-up Sheet	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Perform Piping Systems Pressure Testing section of specifications					Test Report	☑
220519						
Plumbing Meters and Gages						
Verify calibration, adjustment and cleanliness of specified meters and gauges						☐
220553						
Plumbing Identification						
Install valve tags on valves and control devices per specifications					Valve Schedule framed/posted	☐
220716						
Plumbing Equipment Insulation						
Verify correct type, thickness and jacket installed						☐
220719						
Plumbing Piping Insulation						
Verify correct type, thickness and jacket installed						☐
221000						
Plumbing Piping						
Obtain domestic water bacteria test and certification; Notify City of Columbia 48 hours prior to testing if city water is affected					Bacteria Test Certification	☑
Perform plumbing pressure testing section of specifications					Test Report	☑
221119						
Plumbing Specialties						
Perform Testing section of specifications					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
221343						
Facility Packaged Sewage Pumping Stations						
Perform Startup section of specifications					Startup Report	☑
Provide Extra Material as specified					Transmittal	☑
222123						
Plumbing Pumps						
Perform Startup section of specifications					Startup Report	☑
Provide Extra Material as specified					Transmittal	☑
223000						
Plumbing Equipment						
Perform Demonstration section of specifications					Sign-in Sheet	☑
Perform Startup Service section of specifications					Startup Report	☑
226700						
Reverse Osmosis (RO) Water Piping						
Perform Pipe System Cleaning section of specifications					Cleaning Report	☑
Perform Piping System Pressure Testing section of specifications					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
226701						
Water Purification System Equipment						
Perform Field Quality Control section of specifications					Test Report	☑
230500						
Basic HVAC Requirements						
Hold MEP pre-installation meeting(s).					Meeting Minutes	☑
Perform Close Out and Operation Instructions section of specifications					SignIn Sheet	☑
Perform Piping Systems Pressure Testing section of specifications					Test Report	☑
230513						
Electrical Requirements for Mechanical Equipment						
Check each motor for alignment, lubrication, rotation, voltage, current and efficiency					List of motors	☐
230519						
HVAC Meters and Gages						
Provide Test Plugs as specified and as directed by MU owners representative						☐
230593						
Testing, Adjusting, and Balancing						
Coordinate temperature control testing and adjusting with temperature controls contractor						☐
Ensure pre-test requirements as specified in paragraph 1.2C have been completed						☐

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Hold Pre-Balancing Conference as specified					Meeting Minutes	☑
Verify TAB Engineer notified of differences between design and installed equipment						☐
230713						
Ductwork Insulation						
Install pins as specified					Inspection report	☑
230719						
HVAC Piping Insulation						
Verify all piping unions are accessible for maintenance						☐
230900						
Digital Control Equipment						
Calibrate/fine tune circuits & equipment to achieve specified sequence of operation						☐
Check and record amp draw on supply transformers of I/O panels					Test Report	☑
Ensure shipping material has been removed from thermostats and other control devices						☐
Post laminated control diagram in mechanical room						☐
Test and adjust temperature controls in coordination with TAB engineer						☐

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
232113						
Hydronic Piping						
Drain, flush and refill system with clean water.					Flush Report	☑
Pressure test piping per specifications					test report	☑
Provide Extra Material as specified					Transmittal	☑
232123						
HVAC Pumps						
Align all horizontal pumps as specified					Alignment Report	☑
Flush systems until strainers are clean, change strainers and clean vents						☑
Lubricate all motors and bearings						☐
Perform Startup per specifications					Startup Report	☑
Provide Extra Materials as specified					Transmittal	☑
233113						
Ductwork						
Perform Pressure Testing Section of specifications. Leakage class of 4 if no other is specified					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
233300						
Ductwork Accessories						
Perform Field Quality Control Section of spec					Test Report	☑
Test Fire Dampers as specified					Test Report	☑
233423						
HVAC Power Ventilators						
Start-up per manufacturer's written checklist (lubrication, shipping blocks removed, rotation checked, free-turning, etc.) per field quality control section of specs					Startup Report	☑
233600						
Air Terminal Units						
Notify owner's rep after fully installing a representative unit (in-place mockup) for approval. Coordinate and cooperate with owner's commissioning of the boxes.						☐
235200						
Heating Boilers						
Perform Demonstration section of specifications					SignIn Sheet	☑
Perform Field Quality Control section of specifications					O&M Manuals and start-up report	☑
237413						
Dedicated Outdoor Air System						
Perform Manufacturers Field Service section of specs.					field report	☑
Perform Training on System					Sign In Sheet	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
238126						
Split Systems						
Perform Demonstration and Instructions section of spec					SignIn Sheet	☑
Perform Pipe pressure test on refrigeration piping					Test Report	☑
238413						
Humidifiers						
Perform Field Quality Control section of spec					Test Report	☑
Perform Training section of spec					SignIn Sheet	☑
260500						
Basic Electrical Requirements						
Train all End Users on the equipment they will use on a periodic basis per startup, adjustment and instructions section of spec					Sign-in Sheet	☑
Verify underground splices are performed per NEC article 110-14(b) ensuring connections and insulation are rated for underground use						☐
260526						
Grounding System						
Perform resistance test as described in spec					test report	☑
260573						
Low Voltage Electrical System Studies						
Factory certified technician to set electronic overcurrent devices to approved coordination study setpoints					Inspection Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Place arcflash labels on equipment as specified						☑
SKM data to be e-mailed to MU Commissioning Engineer					SKM Data	☑
Train owners representatives in setting of overcurrent devices					Sign-up Sheet	☑
262200						
Low-Voltage Transformers						
Perform checks and tests as noted in spec					Test Report	☑
262413						
Switchboards						
Perform checks per spec					Test Report	☑
262416						
Panelboards						
Perform checks per spec						☑
262550						
Dual Purpose Docking Station						
Perform Field Quality Control section of specifications					test report	☑
262726						
Wiring Devices						
Operate All Devices per spec to verify correct operation					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
262913						
Motor Controllers						
Perform "Field Quality Control" section of spec to verify correct operation					test report	☑
262923						
Variable Frequency Drives						
Provide factory training.					Sign in sheet	☑
Start-up of VFD's shall be by factory rep. Perform all checks per manufacturer's written start-up checklist					field report, certification	☑
263213						
Electrical Emergency Standby Power System Generator Set						
Perform tests per "Onsite Acceptance Testing" section of spec					Test Report	☑
Provide factory training per training section of specs.					Sign in sheet	☑
Verify load is voltage balanced and phasing is correct						☐
Verify proper rotation of generator						☐
264100						
Lightning Protection Systems						
Provide periodic and final inspections as required by LPI-177 in order to obtain UL Master Label					field report, certification, and Master Label	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
265100						
Lighting						
Illuminate emergency lights for 90 minutes on battery power.					Test Report	☑
Perform Field Quality Control section of specifications					Test reports	☑
Test Emergency Lighting fixtures for proper operation					Test Report	☑
283111						
Addressable Fire Alarm System						
Perform Field Quality Control section of specifications					Test Report	☑
Pretest system and ensure all bugs have been rectified					Pretest Checklist	☐
Provide factory training					Sign in sheet	☑
Test system operation of pull stations horns/strobes by factory trained representative					Written certification of fire alarm system per NFP	☑
Verify battery power available						☐
Verify door hardware interlock						☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
285500						
RF Survey for In-Building Two-Way Emergency Responder Communication Enhancement System						
Perform Survey Submittals section of specs					Survey Results	☑
312000						
Earth Moving						
Conduct site compaction tests per contract documents					test report	☐
Help 3rd party with field quality control section of specs					Third Party Report	☑
Hold PreExcavation Conference as specified					Meeting Minutes	☑
Verify correct warning tape type and location prior to backfilling						☑
321313						
Concrete Paving						
Help 3rd party with field quality control section of specs					Third Party Report	☑
329219						
Seeding						
Perform Acceptance section of specifications					Acceptance Report	☑
331100						
Water Utility Distribution Piping						
Perform Cleaning section of specs					Flush report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Provide testing as specified in fire hydrant testing section of specs.					test report	☑
333100						
Sanitary Utility Sewarage Piping						
Perform Field Quality Control section of specifications					test report	☑
334100						
Storm Utility Drainage Piping						
Provide testing as specified in Field Quality Control section.					Test Report	☑

Please see following website for suggested commissioning forms:

https://operations.missouri.edu/facilities/commissioning-forms

Construction Management Checklist for Energizing Utilities

(Contractor to initial each item upon completion and provide completed form to the Owner's Representative prior to energizing utility)

Water – turned on to the first valve past Energy Management's last valve.

- ☐ Review all piping and equipment being turned on for proper installation and completed testing.
- ☐ Insulation installed (preferred but not required)
- ☐ Meter & sensors properly installed, working, remote read operational, and in readable location.
- ☐ Contractor has swabbed out with chlorine all piping from the backflow preventer to the source while installing.
- ☐ All bacteriological tests have been completed and passed.
- ☐ Backflow preventer installed and tested. (will need water pressure to test)
- ☐ Pressure test completed for piping being turned on.
- ☐ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
- ☐ Consultant has signed off.
- ☐ Permitting/Inspection authority has signed off and provided documentation of approval to energize.

Steam – turned on to the first valve past Energy Management's last valve.

- ☐ Review all piping, equipment, valves, reducing stations, relief valves, etc. for proper installation and complete testing.
- ☐ Piping protected from the weather/water.
- ☐ Insulation must be installed.
- ☐ All hangers and bolts have been installed.
- ☐ Meter & sensors installed, working, remote read operational and in readable location.
- ☐ All needed traps are installed and able to be tested as they are turned on.
- ☐ Condensate system is installed and operating including the pumping system.
- ☐ Pressure test completed in piping being turned on.
- ☐ Contractor has method to communicate "Services On" to other contractor personnel and
- ☐ Owner's personnel.
- ☐ Consultant has signed off.
- ☐ Permitting/Inspection authority has signed off and provided documentation of approval to energize.

Condensate – turned on to the first valve past Energy Management's last valve.

- ☐ Review all piping and equipment being turned on for proper installation and completed testing.
- ☐ Piping protected from the weather/water.
- ☐ Insulation must be installed.
- ☐ Pressure test completed in piping being turned on.
- ☐ Contractor has method to communicate "Services On" to other contractor personnel and
- ☐ Owner's personnel.
- ☐ Consultant has signed off.
- ☐ Permitting/Inspection authority has signed off and provided documentation of approval to energize.

Electric – turned on to the first breaker past 13.8kV transformer.

- ☐ Review all wiring and equipment being turned on for proper installation and completed testing.
- ☐ Coordination & Arc Flash studies complete with owner approvals and appropriate labels installed on equipment being energized.
- ☐ GFCI set and tested.
- ☐ Breakers & remote operators set and tested per approved studies.
- ☐ All needed permanent grounds are installed.
- ☐ Meter installed, working and in readable location.
- ☐ Main switchgear protected from the weather/water.
- ☐ Contractor has method to communicate "Services On" to other contractor & Owner's personnel.
- ☐ Consultant has signed off.
- ☐ Permitting/Inspection authority has signed off and provided documentation of approval to energize.

Chilled Water – turned on to the first valve inside of building.

- ☐ Review all piping and equipment being turned on for proper installation and completed testing.
- ☐ Pressure test completed in piping being turned on.
- ☐ Insulation must be installed.
- ☐ Meter installed, working and connected to remote read.
- ☐ Building pump and automatic isolation/control valve must be installed and under control.
- ☐ If chillers are installed, automatic loop pump isolation must be installed.
- ☐ Control valves must be installed and automatically controlled on all loads.
- ☐ Contractor has method to communicate “Services On” to other contractor personnel and Owner’s personnel.
- ☐ Consultant has signed off.
- ☐ Permitting/Inspection authority has signed off and provided documentation of approval to energize.

*Fill out all form fields before signing!

Name	Organization	Title	Signature
University of Missouri Commissioning Authority			

(Place Digital Locking Stamp Here)

END OF SECTION I.E.8

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 1.F

INDEX OF DRAWINGS

Drawings referred to in and accompanying Project Manual consist of following sheets dated 12/21/2023.

Sheet 1	of 89	G0.00	Title Sheet & Drawing Index
Sheet 2	of 89	G0.01	General Notes, Symbols & Abbreviations
Sheet 3	of 89	G0.10	Code Compliance Plan
Sheet 4	of 89	G0.20	Accessibility Details
Sheet 5	of 89	G0.21	Accessibility Details
Sheet 6	of 89	C0.51	Site Erosion Control Plan
Sheet 7	of 89	C0.61	Site Erosion Control Details
Sheet 8	of 89	C1.01	Site Demolition Plan
Sheet 9	of 89	C2.01	Site Layout Plan
Sheet 10	of 89	C3.01	Site Grading Plan
Sheet 11	of 75	C3.11	Enlarged Grading Plan - 1
Sheet 12	of 75	C4.01	Site Utility Plan
Sheet 13	of 75	C4.11	Site Utility Profile
Sheet 14	of 75	C4.12	Site Utility Profiles
Sheet 14	of 75	C5.01	Site Details – 1
Sheet 13	of 75	C5.02	Site Details – 2
Sheet 15	of 75	C6.01	Drainage Area Map & Calculations
Sheet 13	of 75	A0.00	Wall Type Schedule & Details
Sheet 13	of 75	A0.10	First Floor Demolition Floor & Ceiling Plan
Sheet 13	of 75	A1.10	First Floor Plan
Sheet 16	of 75	A2.10	Exterior Elevations
Sheet 17	of 75	A3.10	Building Cross Sections
Sheet 18	of 75	A4.10	Wall Sections
Sheet 19	of 75	A6.10	Interior Elevations
Sheet 20	of 75	A6.40	Door Schedule, Door & Window Types, Frame Types
Sheet 21	of 75	A7.10	Plan Details
Sheet 22	of 75	A8.10	Section Details
Sheet 23	of 75	F1.11	First Floor Finishes Plan & Schedule
Sheet 24	of 75	S0.01	GENERAL NOTES
Sheet 25	of 75	S1.10	FOUNDATION PLAN
Sheet 26	of 75	S1.11	T.O.W. FRAMING PLAN
Sheet 27	of 75	S2.10	FOUNDATION SECTIONS
Sheet 28	of 75	S2.20	FRAMING SECTIONS
Sheet 29	of 75	S5.10	TYPICAL DETAILS
Sheet 30	of 75	S5.11	TYPICAL COLD FORM DETAILS
Sheet 31	of 75	S5.12	EXTERIOR DUCT SUPPORT DETAILS
Sheet 32	of 75	FS1.01	Fire Suppression First Floor Plan - Area B
Sheet 33	of 75	FS1.02	Fire Suppression Schematic
Sheet 34	of 75	M0.00	Mechanical Abbreviations, Symbols & Notes
Sheet 35	of 75	M0.02	First Floor HVAC Piping Demolition Plan - Area A
Sheet 36	of 75	M1.01	First Floor HVAC Plan - Area B
Sheet 37	of 75	M1.02	First Floor HVAC Piping Plan - Area A
Sheet 38	of 75	M1.03	First Floor HVAC Piping Plan - Area B
Sheet 39	of 75	M2.01	First Floor HVAC Air Pressurization Plan
Sheet 40	of 75	M3.01	Mechanical Room 208 & Exterior Mechanical Equipment Plan
Sheet 41	of 75	M3.02	Heating Water System Piping Schematic
Sheet 42	of 75	M4.01	Mechanical Sections
Sheet 43	of 75	M5.01	Mechanical Details
Sheet 44	of 75	M5.02	Mechanical Details
Sheet 45	of 75	M6.01	Mechanical Controls
Sheet 46	of 75	M6.02	Mechanical Controls
Sheet 47	of 75	M6.03	Mechanical Controls
Sheet 48	of 75	M6.04	Mechanical Controls

Sheet 49 of 75 M6.05 Mechanical Controls
Sheet 50 of 75 M7.01 Mechanical Schedules
Sheet 51 of 75 M7.02 Mechanical Schedules
Sheet 52 of 75 P0.01 First Floor Plumbing Demolition Plan - Area A
Sheet 53 of 75 P1.01 Below Floor Plumbing Plan - Area B
Sheet 54 of 75 P1.02 First Floor Plumbing Plan - Area A
Sheet 55 of 75 P1.03 First Floor Plumbing Plan - Area B
Sheet 56 of 75 P2.01 Waste and Vent Riser Diagram
Sheet 57 of 75 P2.02 Water Supply Riser Diagram
Sheet 58 of 75 P3.01 Water System Piping Schematic
Sheet 59 of 75 P3.02 Gas Piping Schematics
Sheet 60 of 75 P4.01 Plumbing Details
Sheet 61 of 75 P4.02 Plumbing Details
Sheet 62 of 75 P5.01 Plumbing Schedules
Sheet 63 of 75 E0.00 Electrical Abbreviations, Symbols Legend & General Notes
Sheet 64 of 75 E0.01 Electrical Site Utilities Plan
Sheet 65 of 75 E0.10 First Floor Electrical Orientation Plan
Sheet 66 of 75 E1.11 First Floor Lighting Plans
Sheet 67 of 75 E2.11 First Floor Power & Auxiliary Systems Plan - West
Sheet 68 of 75 E2.12 First Floor Power & Auxiliary Systems Plan - East
Sheet 69 of 75 E3.01 Electrical One Line Diagram
Sheet 70 of 75 E4.01 Electrical Schedules
Sheet 71 of 75 E4.02 Electrical Schedules
Sheet 72 of 75 E5.01 Electrical Details
Sheet 73 of 75 E5.02 Electrical Details
Sheet 74 of 75 E5.03 Electrical Details
Sheet 75 of 75 E5.04 Electrical Details

END OF SECTION

SECTION 1.G

PREVAILING WAGE RATES

Missouri
Division of Labor Standards
WAGE AND HOUR SECTION

MICHAEL L. PARSON, Governor

Annual Wage Order No. 30

Section 010
BOONE COUNTY

In accordance with Section 290.262 RSMo 2000, within thirty (30) days after a certified copy of this Annual Wage Order has been filed with the Secretary of State as indicated below, any person who may be affected by this Annual Wage Order may object by filing an objection in triplicate with the Labor and Industrial Relations Commission, P.O. Box 599, Jefferson City, MO 65102-0599. Such objections must set forth in writing the specific grounds of objection. Each objection shall certify that a copy has been furnished to the Division of Labor Standards, P.O. Box 449, Jefferson City, MO 65102-0449 pursuant to 8 CSR 20-5.010(1). A certified copy of the Annual Wage Order has been filed with the Secretary of State of Missouri.

Original Signed by
Todd Smith, Director
Division of Labor Standards

Filed With Secretary of State: **March 10, 2023**

Last Date Objections May Be Filed: **April 10, 2023**

Prepared by Missouri Department of Labor and Industrial Relations

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	$58.05
Boilermaker	$73.87
Bricklayer	$53.18
Carpenter	$49.00
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	$47.52
Plasterer	
Communications Technician	$57.48
Electrician (Inside Wireman)	$58.51
Electrician Outside Lineman	$76.79
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	$31.16*
Glazier	$65.21
Ironworker	$65.92
Laborer	$42.86
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	$31.16*
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	$64.73
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	$40.26
Plumber	$69.73
Pipe Fitter	
Roofer	$53.14
Sheet Metal Worker	$56.02
Sprinkler Fitter	$61.21
Truck Driver	$31.16*
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

*The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. The public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.
**The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title as defined in RSMO Section 290.210.

Heavy Construction Rates for
BOONE County

Section 010

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	$48.97
Millwright	
Pile Driver	
Electrician (Outside Lineman)	$74.24
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	$44.32
General Laborer	
Skilled Laborer	
Operating Engineer	$56.12
Group I	
Group II	
Group III	
Group IV	
Truck Driver	*$29.89
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

Use Heavy Construction Rates on Highway and Heavy construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(3).

Use Building Construction Rates on Building construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(2).

If a worker is performing work on a heavy construction project within an occupational title that is not listed on the Heavy Construction Rate Sheet, use the rate for that occupational title as shown on the Building Construction Rate Sheet.

*The Division of Labor Standards received less than 1,000 reportable hours for this occupational title. Public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.

**The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title.

OVERTIME
and
HOLIDAYS

OVERTIME

For all work performed on a Sunday or a holiday, not less than twice (2x) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work.

For all overtime work performed, not less than one and one-half (1½) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work or contractual obligation. For purposes of this subdivision, **"overtime work"** shall include work that exceeds ten hours in one day and work in excess of forty hours in one calendar week; and

A thirty-minute lunch period on each calendar day shall be allowed for each worker on a public works project, provided that such time shall not be considered as time worked.

HOLIDAYS

January first;
The last Monday in May;
July fourth;
The first Monday in September;
November eleventh;
The fourth Thursday in November; and
December twenty-fifth;

If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

END OF SECTION

SECTION 1.H

ALTERNATES

Base Bid may be increased in accordance with following Additive Alternate proposal(s) as Owner may elect:

1. Additive Alternate No. 1: **Electric Heat Sterilizer Unit**
Base Bid: Provide utility rough-in for future installation of sterilizer unit in Room 217A Dirty Corridor for future installation of sterilizer.

Add Alternate: Add new Electric Heat Sterilizer with utility connections. Delete resinous flooring and add concrete sealer; delete resinous cove base.

2. Additive Alternate No. 2: **Steam Heat Autoclave Unit**
Base Bid: Provide utility rough-in for future installation of autoclave unit in Room Mechanical 210; provide wall infill with separate studs and drywall framing including drywall joint to allow for future installation of unit.

Add Alternate: Add new Steam Heat Sterilizer with utility connections and adjacent drywall/metal stud enclosure at each side of unit wall penetration.

3. Additive Alternate No. 3: **Stainless Steel Mobile Casework**
Base Bid: Owner-provided stainless-steel mobile casework at Procedure Rooms.

Add Alternate: Provide stainless-steel mobile casework at Procedure Rooms under construction contract.

4. Additive Alternate No. 4: **Reverse-osmosis piping for animal watering**
Base Bid: Provide piping, connections and terminations to domestic water supply to holding rooms.

Add Alternate: Install piping, connections and terminations from reverse-osmosis equipment to holding rooms in lieu of domestic water piping, connections and terminations.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Geotechnical Report

Proposed Middlebush Farm Building and Parking Lot (CP191901)

Tom Bass Road

Boone County, Missouri

November 12, 2020

Project No. 20120.02

For

The University of Missouri

Columbia, Missouri

Prepared By:

ALLSTATE CONSULTANTS

3312 LeMone Industrial Blvd.,
Columbia, MO 65201

Engineering Our Community

ALLSTATE CONSULTANTS

November 12, 2020

Mr. Kenneth Keane, P.E.
133B General Services Building
900 E Stadium Blvd
Columbia, Missouri 65211

RE: Geotechnical Report
Proposed Middlebush Farm Building and Parking Lot (CP191901)
Boone County, Missouri
Allstate Project No. 20120.02

Dear Mr. Keane;

We have completed the subsurface exploration, laboratory testing and geotechnical engineering report for the Proposed Middlebush Farm Building and Parking Lot to be constructed on the west side of Tom Bass Road in Boone County, south of Columbia, Missouri. The accompanying geotechnical report presents the findings of the subsurface exploration, the results of the laboratory tests and our engineering recommendations regarding earthwork and the design and construction of foundations, floor slab and subgrades for the proposed building and pavement areas.

It has been a pleasure to be of service during the initial phase of this project. If you have any questions regarding this geotechnical report, or if we may be of further service during the design or construction phases, please feel free to contact our office.

Sincerely,

Allstate Consultants LLC

Cassidy Mathews, P.E.
Geotechnical Manager
Missouri: E-2011015772
Enclosures

STATE OF MISSOURI
CASSIDY C. MATHEWS
NUMBER PE-2011015772
PROFESSIONAL ENGINEER
11/12/2020

3312 LeMone Industrial Blvd., Columbia, MO 65201 | P: 573-875-8799 | F: 573-875-8850 | allstateconsultants.net

TABLE OF CONTENTS

TRANSMITTAL LETTER i

TABLE OF CONTENTS ii

INTRODUCTION 1

PROJECT DESCRIPTION 1

FIELD EXPLORATION AND LABORATORY TESTING PROCEDURES 2

SITE DESCRIPTION 3

SUBSURFACE CONDITIONS 4

- Soil Conditions 4
- Groundwater Conditions 5

GEOTECHNICAL EVALUATION AND RECOMMENDATIONS 6

- Geotechnical Evaluation 6
- Earthwork 8
- Building Foundations 10
- Seismicity 11
- Floor Slab Subgrades 11
- Pavement Subgrades 12
- Lateral Earth Pressures for Below Grade Walls 13
- Surface Drainage and Plantings 13
- Additional Considerations 14

CONCLUSIONS AND LIMITATIONS 14

Proposed Middlebush Farm Building and Parking Lot (CP191901)
Tom Bass Road Boone County, Missouri
Allstate Consultants Project No. 20120.02

APPENDIX

Test Boring Location Plan
Test Boring Logs – TB-1 to TB-27

Test Boring Log Notes
Soil and Rock Symbols For Boring Logs
Unified Soil Classification System

Swell Test Reports

GEOTECHNICAL REPORT

PROPOSED MIDDLEBUSH FARM BUILDING AND PARKING LOT (CP191901)
TOM BASS ROAD
BOONE COUNTY, MISSOURI

ALLSTATE PROJECT NO. 20120.02
NOVEMBER 12, 2020

INTRODUCTION

Allstate Consultants LLC has completed the subsurface exploration for the proposed building, parking lot and associated pavements to be constructed at the University of Missouri's Middlebush Farm on the west side of Tom Bass Road in Boone County, Missouri.

Twenty-seven (27) test borings, designated TB-1 through TB-27 were performed to depths ranging from approximately 5 to 20 feet below the existing ground surface in the building, pavement and general site areas in the requested locations. Laboratory tests were performed on soil samples recovered from the borings and the soil samples were visually classified. The Test Boring Logs and Test Boring Location Plan are included in the Appendix.

The purpose of this geotechnical engineering report is to describe the subsurface conditions encountered in the borings, evaluate the field and laboratory test data and to provide recommendations regarding earthwork, the design and construction of foundations, floor slabs and pavement subgrades for the proposed facility.

PROJECT DESCRIPTION

We understand the proposed building will consist of a single story, slab on grade, metal building supported by steel columns. The building will have a footprint of approximately 13,000 square feet and an approximate finished floor elevation of 857.65 feet. Based on our discussions with the Client, there are three concrete pits located on the west side of the proposed building and each will have dimensions of approximately 10 feet by 10 feet wide and will be 10 feet deep. In addition to the currently proposed footprint, there are future additions planned, one to the north and one to the south, each having approximate footprints of 10,000 square feet. A proposed passenger vehicle parking area is planned for the east side of the building and a drive encircling the building is included. The proposed building and pavement areas are shown on the attached Test Boring Location Plan.

Based on the results of Allstate's topographic survey and the proposed finished floor elevation of 857.65 feet, it appears cuts and fills of on the order of 5 feet will be required to develop the floor slab and pavement subgrades. Final structural loads are not yet available, however, based on discussions with the Structural Engineer of Record we estimate wall and column loads will be less than 2 kips/linear foot and 100 kips respectively. If actual structural loads exceed those estimated, we should be notified when loads become available.

FIELD EXPLORATION AND LABORATORY TESTING PROCEDURES

Test borings were staked by an Allstate Consultants survey crew using traditional surveying methods, in the requested locations depicted on the preliminary site plan provided by the Client. Ground surface elevations at the boring locations were determined by the survey crew during staking. Approximate boring locations are shown on the Test Boring Location Plan in the Appendix.

Test borings were performed using Allstate's truck-mounted, Mobile B47 rotary drilling rig and by our drilling subcontractor, Palmerton & Parrish's track-mounted CME 550 ATV rotary drilling rig. Hollow stem augers with a center plug were used to advance the borings. At relatively close vertical intervals, the center plug was removed from the hollow augers and samples of the subsurface materials were obtained using the thin-walled tube and split-barrel sampling methods. Standard Penetration Tests (SPT) were performed during the split-barrel sampling procedure.

As the borings were advanced, a geotechnical engineer recorded the results of the subsurface exploration on field boring logs. Information reported on the field logs included the number, type, depth, recovery, penetration resistance and/or calibrated hand penetrometer reading for each sample. The field logs also included visual descriptions of the recovered soil samples; the geotechnical engineer's interpretation of subsurface conditions between samples based on drilling observations and the drill crew's groundwater observations. Recovered soil samples were sealed to reduce moisture loss and transported to the laboratory for further testing and classification.

Thin-walled tube samples were tested in the laboratory to determine the field water content, dry unit weight and unconfined compressive strength at the time of exploration. The unconfined compressive strength of some of the samples was estimated using a calibrated hand penetrometer. The strength estimated using this device is approximate and was considered accordingly. Split-barrel samples were tested in the laboratory to determine the field water content.

On completion of laboratory testing, the soil samples were described and classified in general accordance with the Unified Soil Classification System (USCS) using visual-manual procedures. USCS Group Letter Symbols and Group Names were also assigned based on visual-manual estimates. Atterberg limit tests were performed on selected samples to assist in soil classification and evaluating the engineering characteristics of the site soils and the results of these tests are shown on the test boring logs.

Six (6) swell tests were conducted on thin-walled tube samples of the subgrade soils to assist in evaluating the potential for future heave of foundations and floors slabs since expansive soils are common to the project area. Swell tests were conducted by trimming soil samples, at the in-situ moisture content and density prevailing at the time of exploration, into fixed ring consolidometers; applying surcharge pressures approximately equal to the effective vertical stresses anticipated after construction is complete and measuring the amount of vertical swell resulting from inundating the samples with water.

The final Test Boring Logs included in this report present the results of the field exploration and the laboratory testing program. The final logs delineate the soil strata encountered in the borings and represent the geotechnical engineer's interpretation of subsurface conditions at the boring locations. These interpretations were developed from a review of the field boring logs with modifications based on the laboratory test results and on visual observations of the recovered samples. Graphical symbols depicting the soil strata are shown on the boring logs for illustrative purposes. It should be recognized that differing soil types could be present between samples and between borings.

The Test Boring Log Notes included in the Appendix describe the symbols used on the Test Boring Logs and provide additional information regarding sampling procedures; soil and rock descriptions and classification; Standard Penetration Tests; laboratory test results; the consistency of fine grained soils; the relative density of coarse grained soils; bedrock quality and borehole water level observations.

The Unified Soil Classification System is also described in the Appendix and a legend is included relating graphical symbols used on the boring logs to the USCS Group Letter Symbols and Names and to the principal rock types encountered in the project area.

SITE DESCRIPTION

The proposed building will be located on a very gently sloping upland site on the west side of Tom Bass Road and US Highway 63, south of Columbia, Missouri as shown on

the Test Boring Location Plan. The building site was covered with perennial grass at the time of exploration and no trees were observed in the building area.

Ground surface elevations in the proposed project area typically ranged from 870 feet on the south to 850 feet on the north and surface drainage was generally from the higher terrain on the south to the lower topography on the north.

SUBSURFACE CONDITIONS

Subsurface conditions encountered at the individual boring locations are indicated on the Test Boring Logs. Stratification lines shown on these logs represent approximate boundaries between soil types. In-situ, the change between material types may be more gradual. Based on a review of the Test Boring Logs, subsurface conditions at the project site can be characterized as follows:

Soil Conditions

Test borings TB-1 to TB-12 and TB-24 to TB-27, located in the proposed building and future building addition areas, generally encountered some 12 inches of topsoil over native loessial, post-glacial, and glacial soil deposits. These building area borings were terminated in glacial drift at depths of approximately 20 feet beneath the existing ground surface. Pavement area and general site borings, TB-13 to TB-23, typically encountered 12 inches of topsoil over native loessial soil deposits extending to approximately 5 feet below the existing ground surface.

The surficial native loessial deposits had a well-developed weathering profile and typically extended to depths of about 5 to 8 feet beneath the existing ground surface in most of the borings. These windblown deposits have been preconsolidated by repeated cycles of wetting and drying since deposition and have a well-developed soil profile as a result of long-term leaching and weathering. The weathered loess profile encountered in the borings generally consisted of an A horizon composed of topsoil over a thin B horizon consisting of highly weathered, lean clay and fat clay and the underlying parent soil or C horizon composed primarily of the parent lean clay loess.

The relatively thick topsoil or A horizon loess encountered in the test borings typically extended to depths of about 12 inches beneath the surface and consisted chiefly of lean clay. Although the root zone and most of the organic matter was observed in the upper several inches of the A horizon, the underlying material was also silty and had some of the textural characteristics of a silty lean clay topsoil. These type soils typically become low in strength when wet and can be spongy and elastic under construction traffic.

Below the A horizon, many of the test borings encountered the highly weathered, B horizon loess. These high plastic, lean clays and fat clays were observed in most of the borings and extended to depths of about 2.5 to 5 feet beneath the existing ground surface. The soils encountered in the B horizon were typically moist and stiff to very stiff and occasionally medium or hard in consistency at the time of exploration.

The highly weathered, lean clay and fat clay loess was generally underlain by the parent C horizon soil in the borings. These loessial materials typically consisted of lean clay of stiff to very stiff and occasionally medium or hard consistency soils. The C horizon loess extended to depths of about 5 to 8 feet beneath the surface in most of the borings.

Beneath the weathered loess, most borings encountered a few feet of a post-glacial soil deposit known as the Ferrelview Formation. The post-glacial waterlain soils have been preconsolidated by past desiccation since deposition and consisted of predominantly fat clays of stiff to very stiff consistency.

At depths ranging from about 8 to 13 feet, most of the deeper building borings transitioned from the thin Ferrelview Formation to the underlying Pre-Illinoian glacial drift. The preconsolidated, glacial drift typically consisted of stiff to very stiff or occasionally hard, lean clay with a higher sand content than the overlying soils. One test boring, TB-8, encountered a zone of loose to medium dense clayey sand. It is not uncommon for the underlying glacial drift of the project area to contain extensive lenses and zones of medium dense to very dense, silty sand, clayey sand and silt. These semi-pervious deposits are often semi-confined in the deeper glacial drift and can bear groundwater under artesian pressure.

Groundwater Conditions

Field observations were periodically made during drilling and sampling and immediately after boring completion to measure borehole water levels. Groundwater was not observed at these times in the test borings. Extended water levels were not observed prior to backfilling the boreholes with auger cuttings.

It should be recognized that short term water level observations in open boreholes, drilled into low permeability soil, may not represent actual groundwater conditions in these materials. In fact, a considerable length of time may be required for a groundwater level to be detected and to stabilize in an open borehole extending into materials similar to those encountered in the test borings at this site.

Installation and long-term observation of piezometers or groundwater observation wells, screened in the hydrologic units of interest and sealed to prevent the entrance of surface water, would be required to more accurately characterize and evaluate groundwater

levels and fluctuations in these levels in this geologic setting. While these services can be provided if requested, they are beyond the scope of this investigation.

Groundwater levels often vary across a project site and typically fluctuate at individual locations with variations in seasonal and climatological conditions. Perched water tables can develop and groundwater levels can be influenced by alterations in site grades, other construction activities, modifications to adjacent sites, leaking utility piping, water following utility trench backfill and other factors not readily evident at the time the borings are performed.

During construction and at other times during the life of the proposed development, groundwater levels may be higher or lower than the levels reported on the boring logs. The likelihood of fluctuating groundwater levels and the potential occurrence of seasonally perched groundwater in the near surface soils, such as the silty A horizon and C horizon loess, should be appropriately considered during development of design and construction plans for this project.

GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

Geotechnical Evaluation

Building area test borings TB-1 to TB-12 and TB-24 to TB-27, encountered native loessial soils with a well-developed soil profile and underlying post-glacial and glacial soil deposits. Beneath the approximate 12 inch thick A horizon topsoil, borings typically encountered highly weathered and higher plastic B horizon soils chiefly composed of lean clays and fat clays extending to depths of about 2.5 to 5 feet over parent C horizon loess generally consisting of lean clays extending to depths of about 5 to 8 feet beneath the surface. The loessial soils were typically underlain by stiff to very stiff, predominantly fat clays of the Ferrelview Formation and underlying Pre-Illinoian glacial drift comprised of stiff to hard lean clays and occasional clayey sands.

The A horizon topsoil was dry to moist at the time of exploration while the underlying B horizon soils were typically moist and stiff to very stiff in consistency where they were identified. The deeper C horizon lean clays were generally moist and stiff to very stiff and occasionally hard at the time of exploration.

Preliminary plans indicate the floor slab and interior foundations of the proposed building may be supported by the higher plastic B horizon clays or controlled compacted fill and the exterior foundations by either controlled compacted fill, B horizon clays or C horizon lean clays depending on location.

Since expansive soils are commonly encountered in the project area, Atterberg limits tests were performed on samples of the native soils to assist in evaluating the general engineering characteristics of these loessial site soils. Atterberg limit testing indicated samples of the highly weathered, B horizon lean clays and fat clay were moderately to highly plastic having a liquid limits ranging from approximately 44 to 63 and plasticity indices or PI's of 24 to 38 which are considered to be high.

Past experience indicates the highly weathered, B horizon clays can have a high to very high swell potential and the underlying C horizon lean clays can have a low to moderate swell potential if these soils have low moisture levels prior to construction. The low to moderate moisture levels, high densities and strengths encountered in some of the borings at the time of exploration tend to indicate moderate to high swell potentials in the B horizon clays.

To assist in evaluating the swell potential of the site soils in their current condition, laboratory swell tests were performed on representative soil samples obtained from the upper portion of the soil profile in borings TB-1, TB-6, TB-7 and TB-12. Swell tests were performed on soil samples at the in-situ moisture and density under surcharge pressures of 125 to 750 psf to simulate future effective stresses due to combined floor loads and the weight of the existing overburden soils. The results of these tests are provided in the Appendix.

Following inundation with water under surcharge pressures of 125 to 750 psf, samples of the dry to moist, B horizon clays from depths of 1 to 5 feet beneath the existing ground surface had a measured swell potential of approximately 0.1 to 3.1 percent which considered to be low to high. Under surcharge pressures of 500 psf, a sample of the deeper C horizon lean clays from a depth of about 5 feet beneath the existing ground surface had a swell potential of 0.3 percent indicating these soils have a relatively low swell potential.

Based on the results of our limited swell testing program, the site soils appear to have a moderate swell potential or tendency to cause heaving of floor slabs and lightly loaded foundations. The variability of the swell potential due to the gently sloping nature of the existing terrain and the anticipated cuts and fills will likely cause differential moisture induced volume change that could cause undesirable floor slab performance if these soils are not addressed. Subgrade drying and moisture loss could also result in higher swell potentials than were measured.

Based on the type of structure planned and our experience with expansive soils in the project area, we recommend establishing a 24-inch-thick, low volume change zone beneath the proposed building floor slab to reduce future floor slab heave to tolerable levels. While a less substantial low volume change zone, such as one having thickness

of 12 to 18 inches, could be used, there is a potential that building floor movements would be more significant and more noticeable with a thinner low volume change zone. Additionally, we are of the opinion that shallow foundations can be used for support of the building as recommended in later sections of this report.

For this project, close attention will need to be paid to removal of any unsuitable site soils; controlled placement and compaction of fill materials and any low volume change zones; and observation of foundation bearing surfaces. Detailed recommendations for design and construction of earthwork, foundations and floor slab subgrades are provided below.

Earthwork

Prior to earthwork, existing vegetation and any low strength topsoil should be undercut from the proposed fill areas, pavement areas and from the footprint of the proposed building and for a horizontal distance of 5 feet beyond the building limits.

After vegetation and topsoil stripping, any remaining loose or otherwise unsuitable material that may be present should be removed from the proposed building and pavement areas. Undercutting in the building area should extend to the bottom of the 24-inch-thick low volume change zone beneath the building floor slab.

Prior to controlled compacted fill placement, the exposed native soils in the pavement areas and the building area undercut should be systematically proof-rolled with a loaded tandem axle dump truck or loaded scraper in the presence of the geotechnical engineer of record or his on-site representative. If additional unsuitable materials are identified in the bottom of the building area undercut during controlled proof-rolling, these unsuitable materials should also be removed to stiff, native clay as determined by the geotechnical engineer of record or his on-site representative. The bottom of the undercut should be scarified to a minimum depth of 4 inches; moisture conditioned to the optimum moisture content or above; recompacted with a sheepsfoot or padfoot roller and backfilled with controlled, compacted fill as described below.

Controlled, compacted fill should be placed in lifts having a maximum loose thickness of 8 inches. Lean clay soils, suitable for reuse as controlled, compacted fill, should be placed and moisture conditioned to within the range of the optimum moisture content to 3 percent above the optimum moisture content and compacted to at least 95 percent of the standard Proctor maximum dry density (ASTM D698). Fat clay soils, suitable for reuse as controlled, compacted fill placed at least 5 feet beyond the proposed building footprint, should be placed and moisture conditioned to within the range of 2 percent above to 5 percent above the optimum moisture content and should be compacted to the same requirements. Silty lean clay soils, suitable for use as controlled, compacted fill

that have liquid limits less than 40, should be placed and moisture conditioned to within the range of 1 percent below to 2 percent above the optimum moisture content and compacted to at least 95 percent of the standard Proctor maximum dry density (ASTM D698). Sheepsfoot and/or padfoot rollers are recommended for compaction of clay soils.

We recommended establishing a 24-inch-thick low volume change zone beneath the building floor slab consisting of approved densely graded granular materials containing at least 15 percent low plasticity fines passing the No. 200 sieve such as MODOT Type 1 crushed limestone, limestone screenings or wastelime. Approved granular materials should be placed in 8-inch-thick loose lifts and compacted at workable moisture contents to at least 95 percent of the standard Proctor maximum dry density (ASTM D698). Vibratory rollers are recommended for compaction of granular soils. In any confined areas, such as plumbing trenches, hand operated compactors and 4-inch-thick lifts are recommended.

Samples of on-site or off-site clays or off-site granular fill, proposed for use in controlled compacted fills or the low volume change zone should be obtained by the geotechnical engineer for evaluation prior to being used at the site.

Each lift of controlled, compacted fill or low volume change material should be observed during placement and compaction and should be subjected to in-place field density testing by the geotechnical engineer of record's on-site representative. Should the field density test results indicate the recommended moisture and compaction levels have not been achieved, the area(s) represented by the test(s) should be reworked and/or recompacted and retested until the moisture and compaction requirements are met.

New utility trench backfill located within 5 feet of the outside of the proposed building should consist of clay soils placed and compacted at the optimum moisture content or above and to the compaction requirements described in this report for controlled, compacted fill.

We recommend the geotechnical engineer of record be retained by the Owner during earthwork construction to perform necessary tests and observations during removal of unsuitable materials; proof-rolling of subgrades; placement and compaction of controlled compacted fills and granular low volume change zones, if used; backfilling of utility trench, foundation and other excavations and final subgrade preparation just prior to floor slab construction.

Building Foundations

In our opinion, the proposed building can be supported on shallow foundations if the recommendations of this report are followed. Building foundations can be supported on stiff native site soils similar to those encountered below a depth of 2 to 4 feet in the borings or on controlled, compacted fill constructed as recommended in the ***Earthwork*** section of this report.

Shallow building foundations supported as described above should be proportioned using a net allowable total load design bearing pressure of 2,000 psf. The net allowable bearing pressure refers to the pressure at the footing bearing level in excess of the minimum surrounding overburden pressure.

Footings beneath unheated areas and footings around the perimeter of the building should extend to a minimum depth of at least 3 feet below the lowest adjacent finished grade for frost protection and to reduce the effects of seasonal, moisture-related volume change in the supporting soils. We recommend isolated footings have a minimum width of 30 inches and continuous wall footings a minimum width of at least 18 inches and such additional width as necessary to support total design loads.

The foundation subgrade soils will be sensitive to moisture changes and construction traffic and every effort should be made to minimize disturbance and wetting of these soils during excavation, final cleanup, observation of bearing surfaces and placement of reinforcement and concrete. We recommend any foundation excavation opened on a given day be reinforced and provided with concrete on the same day.

New building foundations may be subjected to lateral loading. For lateral loads of short duration, we recommend sliding be resisted by an allowable base adhesion of 350 psf acting on the bottom contact area of the foundation that is in compression or by an allowable passive resistance of 700 psf acting on the vertical face of the foundation element in the direction perpendicular to the lateral load. Passive resistance should not be relied upon within 3 feet of finished grade. For any sustained lateral loads of long duration, we recommend an ultimate coefficient of friction of 0.3 be used on the bearing area of the foundation that is in compression. An appropriate factor of safety should be applied to the ultimate base resistance calculated using this value.

Surface water and/or perched groundwater may enter foundation excavations during construction. In our opinion, water entering foundation excavations from these sources can and should be promptly removed using sump pumps.

The bearing surface of all foundation excavations should be free of water and loose or unsuitable soil prior to placing concrete. Reinforcement and concrete should be placed

soon after excavation to minimize disturbance of the bearing surface and supporting soils. Should the bearing soils become dry, disturbed, saturated, or frozen, the impacted soil should be removed to suitable material prior to placing concrete. The geotechnical engineer of record should be retained to observe and test the foundation bearing materials during construction as low strength materials may be encountered requiring undercutting and/or modification of footing depths.

Use of the site preparation procedures recommended in this report will greatly reduce the potential that unsuitable soils will be encountered in foundation excavations. However, if unsuitable bearing materials are identified by the geotechnical engineer or his on-site representative, the foundation excavations should be extended deeper to suitable soils. Foundations could bear directly on these deeper suitable materials or on lean concrete backfill placed in the excavations. Foundations could also bear on controlled compacted clay fill extending down to the suitable materials and placed and compacted as recommended in this report. Over-excavations for placement of compacted backfill below foundations should extend at least 1 foot horizontally beyond all footing edges for each foot of over-excavation depth below the footing bearing elevation. Where controlled compacted backfill is placed in confined spaces and compacted with hand operated equipment, the lift thickness will need to be reduced to 4 inches to achieve the recommended compaction levels.

Foundations designed and constructed on subgrades prepared as recommended in this report are expected to experience total settlements on the order of approximately 1 inch or less and differential settlements between adjacent foundation elements of approximately ½ to ¾ of an inch or less.

Seismicity

Building foundations should be capable of supporting earthquake loads as stipulated in the International Building Code (IBC) or other such applicable code as determined by the structural engineer of record. Based on the results of the subsurface exploration and our experience with geologic conditions in the project area, we recommend the proposed site be classified as Site Class C as defined in Table 20.3-1 and Section 20.3 of the ASCE *Minimum Design Loads for Buildings and Other Structures* if IBC, 2018 governs the design.

Floor Slab Subgrades

After floor slab subgrade construction is complete, care should be taken to maintain the recommended subgrade moisture and density prior to placement of the building floor slab. Completed subgrades that experience moisture loss or become saturated, frozen,

disturbed or altered by plumbing installations or other construction activity should be reconditioned to meet the recommendations of this report prior to floor slab placement.

We recommend a free-draining, compacted, granular leveling course be placed below the floor slabs to provide a capillary break and uniform floor slab support. The thickness of this layer should be at least 4 to 6 inches and the layer can be considered a part of the low volume change zone. For floor slab subgrades prepared as recommended in this report, the concrete slab can be designed using a modulus of subgrade reaction, k, of 100 pounds per square inch per inch (psi/in).

Pavement Subgrades

Pavement subgrades should be developed and prepared as recommended in the ***Earthwork*** section of this report. Fill should consist of moisture conditioned, controlled compacted lean clay fill free of organic matter and debris. We recommend that at least the upper 12 inches of the soil subgrade in cut and shallow fill areas consist of moisture conditioned, controlled compacted lean clay fill placed and compacted at the optimum moisture content to 4 percent above the optimum moisture content and to at least 95 percent of the standard Proctor maximum dry density (ASTM D698).

Pavement subgrades prepared properly during the early stages of construction may be altered by the passage of time, weather and ongoing construction activities. These subgrades should be carefully evaluated by the geotechnical engineer or his on-site representative and should be properly reconditioned prior to base course placement and paving. Close attention should be paid to restoration of heavily traveled areas that were rutted and disturbed during construction and to areas where utility trenches have been backfilled. We recommend these areas and all other pavement subgrades be moisture conditioned and re-compacted to meet the requirements of controlled compacted fill just prior to finish grading, base course placement and paving. Unsuitable subgrades identified in this process should be reworked and re-compacted or removed and replaced with materials meeting the requirements of controlled compacted fill.

Based on the results of the test borings and our previous experience with the types of soils encountered at the project site and proposed in this report for use in the moisture conditioned, controlled compacted subgrades, we recommend a soaked CBR value of about 2 or a resilient modulus, M_r, of about 3000 psi be used to develop any flexible asphalt pavement sections. A modulus of subgrade reaction, k, of about 75 to 100 psi/in can be used to develop rigid pavement designs. Geogrids such as Tensar TX 160 used in conjunction with nonwoven geotextiles and crushed stone base material are recommended to remediate soft subgrades; enhance pavement performance and to reduce the overall thickness of the pavement sections. If pavement subgrade preparation does not follow the recommendations of this report, lower CBR values and

subgrade reaction moduli may be encountered and unsatisfactory pavement performance may develop.

Lateral Earth Pressures for Below Grade Walls

We understand the concrete pits could retain up to 10 feet of backfill and may be cast in place concrete or precast concrete construction. Walls retaining earth backfill and surcharge loads on one side will be subjected to lateral earth pressures. Concrete walls that are provided with appropriate lateral support at the top and bottom are commonly designed for the “at rest” lateral earth pressure. This earth pressure is the minimum lateral pressure that should be used to design restrained walls that will experience essentially no wall rotation. Additional lateral earth pressures can develop that exceed the “at rest” earth pressures. The actual earth pressures developed will depend on the structural design, wall bracing and restraint, construction sequence and methods, backfill compaction procedures and the shear strength of the wall backfill.

For the “at rest” condition, we recommend the concrete walls be designed for an earth pressure equivalent to that of a fluid exerting a lateral pressure of at least 90 pounds per cubic foot (pcf) and 100 pounds per cubic foot (pcf) per foot of wall height for granular backfill and lean clay backfill respectively.

The above minimum design earth pressures do not include a factor of safety and assume the wall backfill will consist of controlled, compacted, lean clay or granular fill placed in horizontal lifts as recommended in this report. The recommended minimum design earth pressures do not include the additional lateral stresses that can develop during compaction of the wall backfill or due to heavy construction equipment that may be operated too close to walls or other surcharge loads that may be present above or below finished grade. The minimum design earth pressures also do not account for possible hydrostatic forces that may develop on the walls due to the presence of groundwater.

In our opinion, the backfill placed behind these type walls should consist of granular fill. The design earth pressures recommended for granular backfill are only valid if the granular backfill extends out from the heel of the wall footing at an angle of 45 degrees or less from the horizontal.

Surface Drainage and Plantings

We recommend final grading plans rapidly direct surface run-off away from building and pavement areas wherever possible. Roof gutter and downspout discharge should be channeled well away from building and pavement areas to reduce the potential that water will accumulate adjacent to these facilities. Any future foundation and/or utility

trench backfill settlement around the perimeter of the building should be corrected to prevent ponding of water in the building and pavement areas. We recommend that plants and trees with significant moisture requirements not be located adjacent to the building.

Additional Considerations

The clay soils in the project area are prone to shrinkage and swelling with variations in moisture content. High plasticity soils such as fat clay generally have a greater potential for moisture induced volume change than less plastic materials such as lean clay. However, even lean clay can shrink and swell with variations in moisture levels. We recommend subgrades be constructed as recommended in this report and that close attention be paid to maintaining moisture levels in subgrades prior to installation of floor slabs and sidewalks; providing adequate surface drainage and keeping plants and trees well outside the area where they can adversely influence building performance.

The procedures recommended in this report may not eliminate all future subgrade volume change and resultant foundation and floor slab movement. However, the recommendations described in this report should reduce the potential for consolidation settlement, subgrade volume change and future building movements to reasonably uniform and tolerable levels. If minor floor movements and occasional cosmetic cracks are not tolerable, then other site preparation procedures would need to be implemented.

CONCLUSION AND LIMITATIONS

The authorized geotechnical engineering services have been completed. The resulting geotechnical recommendations included in this report provide a basis for development of earthwork, foundation, and floor slab and pavement subgrade designs for the proposed facility. We recommend that Allstate Consultants be retained to review the final project plans and specifications so that we can comment on and assist in the interpretation and implementation of our geotechnical recommendations.

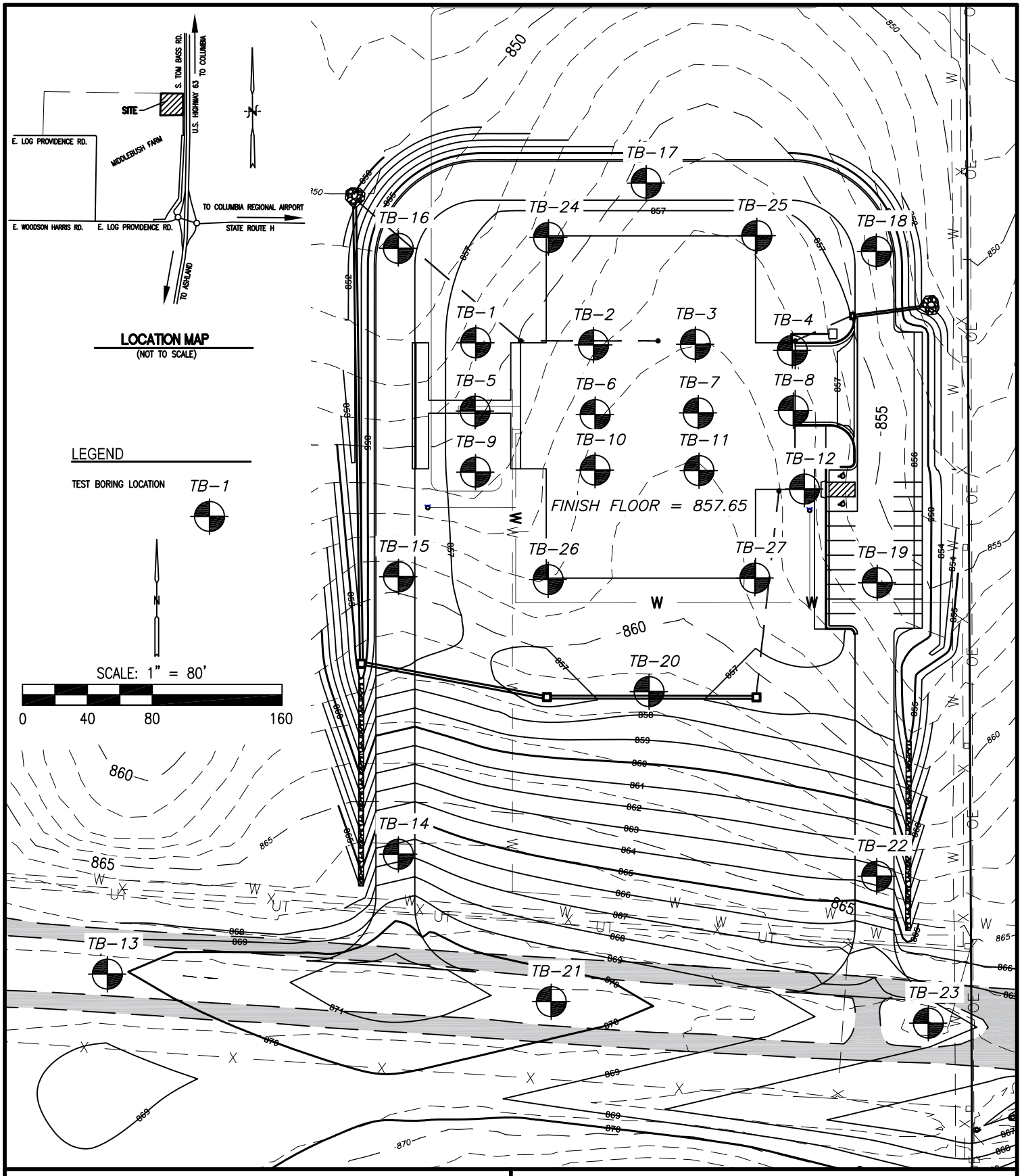
Allstate Consultants should be retained during construction of this project to provide geotechnical observation and testing services for earthwork, foundation, and floor slab construction.

The evaluations, analyses and recommendations provided in this report are based on the subsurface conditions encountered in the test borings performed at the locations indicated on the Test Boring Location Plan and from other information discussed in this report. Our geotechnical report does not consider variations that could occur between boring locations or changes that may occur due to the passage of time, the modifying effects of weather or adjacent construction activities. The character and extent of such

variations may not become evident until during or after construction. Should variations be identified, we should be notified immediately so that further evaluations and additional recommendations can be developed.

The scope of our geotechnical engineering services does not include either specifically or by implication any environmental evaluation of this site nor identification of contaminated or hazardous materials or conditions. Further, we have performed no assessment of the possible presence of bacteria or fungi nor the potential for development of problems associated with mold. If the Owner is concerned about the potential for such issues, other environmental studies should be performed.

This geotechnical report has been prepared for the exclusive use of our client for specific application to this project only and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended to be made. During construction, site safety, excavation support, and dewatering will be the responsibility of others. Should changes occur in the nature, design or location of the proposed building and pavement areas, as described in this report, the evaluations, recommendations and conclusions contained herein shall not be considered valid unless Allstate Consultants reviews the changes and provides written verification or modification of the conclusions of this report.



ALLSTATE CONSULTANTS
3312 LEMONE INDUSTRIAL BLVD.
COLUMBIA, MISSOURI 65201
phone (573) 875-8799
fax (573) 875-8850
allstateconsultants.net

TEST BORING LOCATION PLAN
PROPOSED MIDDLEBUSH FARM BUILDING AND PARKING LOT (CP191901)

BOONE COUNTY, MISSOURI

PROJECT NUMBER:	SCALE	DATE
20120.02	1"=80'	10–30–2020

TEST BORING LOG

BORING NO. 1

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 853.6		PL — LL; 10 20 30 40 50 60		
						12" TOPSOIL				
	1	3ST	23	CH		**FAT CLAY,** Brown Mottled Tan,		PL 22.1 LL	95	3730
						3 Jointed, Stiff, CH 850.6		20 54		
	2	3ST	22	CL		**LEAN CLAY,** With Silt,		17.9	104	3940
5						5 Gray Mottled Tan, Stiff, CL 848.6				
	3	3ST	21	CH		**FAT CLAY,** Trace Sand,		26.5	98	1990
						Gray Mottled Tan, Jointed,				
						8 Medium, CH 845.6				
	4	3ST	23	CL		**LEAN CLAY,** With Sand,		17.9	111	3350
10						Yellow Brown Mottled Gray,				
						Stiff, CL				
						Grading Very Stiff to Hard				
15	5	SS	18	CL			3/6/6	17.4		*8000
						Grading Very Stiff				
20	6	SS	18	CL		20 833.6	3/6/6	17.9		*7500
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/26/2020
COMPLETED: 10/26/2020 **BORING NO. 1**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 2

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 856.7				
						12" TOPSOIL				
	1	SS	12	CL		**LEAN CLAY,** With Silt,	3/4/4	20.5		*9000+
						3 Gray, Hard, CL 853.7				
5	2	SS	14	CH		**FAT CLAY,** Brown Mottled Tan, 5 Very Stiff to Hard, CH 851.7	4/6/7	17.6		*8000
	3	SS	18	CH		**FAT CLAY,** Trace Sand, Gray Mottled Tan, Very Stiff, CH	2/3/4	25.7		*4500
10	4	SS	18	CH		12 844.7	2/3/4	23.4		*5500
15	5	SS	18	CL		**LEAN CLAY,** Trace Sand & Gravel, Yellow Brown Mottled Gray, Very Stiff, CL	3/3/4	19.3		*5500
20	6	SS	18	CL		20 836.7	3/5/7	18.2		*6000
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/26/2020
COMPLETED: 10/26/2020 **BORING NO. 2**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 3

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 858.0				
						12" TOPSOIL				
	1	SS	14	CH		**FAT CLAY,** Brown Mottled Tan,	3/3/5	18.3		*6000
						3 Very Stiff, CH 855.0				
5	2	SS	18	CL		**LEAN CLAY,** Gray Mottled Tan, Very Stiff, CL	3/3/5	18.7		*6000
	3	SS	18	CL		Grading Stiff to Very Stiff	2/3/4	23.1		*4000
						8 850.0				
10	4	SS	18	CH		**FAT CLAY,** Trace Sand, Gray Mottled Tan, Very Stiff, CH	2/3/3	26.0		*4500
						13 845.0				
15	5	SS	16	CL		**LEAN CLAY,** With Sand, Trace Gravel, Yellow Brown Mottled Gray, Stiff, CL	2/3/2	22.4		*3000
20	6	SS	13	CL		With Gravel, Yellow Brown Mottled Tan, 20 Very Stiff 838.0	8/8/12	18.5		*6000
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/27/2020
COMPLETED: 10/27/2020 **BORING NO. 3**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 4

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 856.9				
						12" TOPSOIL				
	1	3ST	15	CH		FAT CLAY, Brown Mottled Tan,		28.0	92	1860
						3 Jointed, Medium, CH 853.9				
	2	3ST	15	CL		LEAN CLAY, Gray Mottled Tan,		18.4	111	*5500
5						5 Very Stiff, CL 851.9				
	3	3ST	23	CH		FAT CLAY, Trace Sand,		21.2	106	3190
						Gray Mottled Tan, Jointed,				
						Stiff, CH				
	4	3ST	23	CH				24.8	99	3020
10										
						13 843.9				
						LEAN CLAY,				
	5	SS	18	CL		With Sand, Trace Gravel,	3/3/6	20.7		*5500
						Yellow Brown Mottled Gray,				
						Very Stiff, CL				
						Grading Medium to Stiff				
15	6	SS	6	CL		20 836.9	4/6/7	17.7		*2000
20						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/27/2020
COMPLETED: 10/27/2020 **BORING NO. 4**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 5

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 854.7				
						12" TOPSOIL				
	1	SS	6	CL		LEAN CLAY, Brown, Hard, CL	5/6/5	17.8		*9000+
						3 851.7				
5	2	SS	8	CH		FAT CLAY, Tan Mottled Gray, Very Stiff, CH 5 849.7	3/3/4	23.9		*6000
	3	SS	18	CH		FAT CLAY, Trace Sand, Gray Mottled Tan, Very Stiff, CH 8 846.7	3/3/4	22.7		*5000
10	4	SS	18	CL		LEAN CLAY, With Sand, Yellow Brown Mottled Gray, Very Stiff, CL	2/4/5	18.3		*7000
15	5	SS	18	CL		Grading Very Stiff to Hard	4/5/7	17.4		*8000
20	6	SS	18	CL		Grading Hard 20 834.7	4/6/7	17.5		*8500
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/26/2020
COMPLETED: 10/26/2020 **BORING NO. 5**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 6

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 857.8		PL — LL (10 20 30 40 50 60)		
						12" TOPSOIL				
	1	3ST	24	CL		**LEAN CLAY,** Brown Mottled Tan, 3 Jointed, Stiff CL 854.8		PL 18.7, 19; LL 47	99	3970
	2	3ST	23	CL		**LEAN CLAY,** Gray Mottled Tan, 5 Very Stiff, CL 852.8		PL 17.0, 17; LL 44	108	5370
5	3	3ST	18	CH		**FAT CLAY,** Trace Sand, Gray Mottled Tan, Jointed, Stiff, CH		22.0	104	3070
	4	3ST	22	CH		Grading Medium		28.1	96	1760
10						13 844.8				
	5	SS	18	CL		**LEAN CLAY,** With Sand, Yellow Brown Mottled Gray, Very Stiff, CL	3/3/5	20.1		*4500
15										
	6	SS	18	CL		20 837.8	3/6/6	17.9		*7000
20						**BOTTOM OF BORING AT 20 FT.**				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/26/2020
COMPLETED: 10/26/2020 **BORING NO. 6**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 7

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION		SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation:	858.5		PL 25 — 36.5 — LL 63		
						12" TOPSOIL					
	1	3ST	18	CH		**FAT CLAY,** With Organics, Brown, Soft, CH	855.5			74	870
5	2	3ST	20	CL		**LEAN CLAY,** Gray Mottled Tan, Stiff, CL			22.1	102	2210
	3	3ST	13	CL		Grading Medium			23.1	103	*1500
							850.5				
10	4	3ST	22	CH		**FAT CLAY,** Trace Silt, Gray, Soft, CH			31.5	90	990
							845.5				
15	5	SS	18	CL		**LEAN CLAY,** With Sand, Trace Gravel, Yellow Brown Mottled Gray, Very Stiff, CL		2/3/4	20.7		*4500
20	6	SS	18	CL			838.5	3/4/5	18.4		*6000
						BOTTOM OF BORING AT 20 FT.					
25											
30											
35											

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/27/2020
COMPLETED: 10/27/2020 **BORING NO. 7**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 8

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 857.4				
						12" TOPSOIL				
	1	SS	14	CH		FAT CLAY, Tan Mottled Orange,	1/3/4	26.6		*4500
						3 Very Stiff, CH 854.4				
5	2	SS	18	CL		LEAN CLAY, Tan Mottled Gray, Very Stiff, CL	2/4/6	19.7		*6500
	3	SS	18	CL		Grading Gray, Stiff	2/3/3	24.3		*2500
						8 849.4				
10	4	SS	18	CH		FAT CLAY, Trace Sand, Gray Mottled Tan, Stiff to Very Stiff, CH	2/2/4	24.6		*4000
						13 844.4				
15	5	SS	17	SC		CLAYEY SAND, Orange Tan, Loose to Medium Dense, SC	3/5/5	17.5		
						Grading Loose				
20	6	SS	18	SC		20 837.4	2/4/3	22.2		
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/27/2020
COMPLETED: 10/27/2020 **BORING NO. 8**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 9

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 855.2				
						12" TOPSOIL				
	1	3ST	24	CL		**LEAN CLAY,** Gray, Medium, CL		23.0	103	1950
	2	3ST	22	CL		Grading Dark Gray Mottled Brown, Stiff		22.6	101	2760
5	3	3ST	24	CL		Grading Gray Mottled Tan		23.0	102	3170
						8 847.2				
	4	3ST	22	CL		**LEAN CLAY,** With Sand, Yellow Brown Mottled Gray, Jointed, Stiff, CL		20.7	108	3670
10										
						Grading Very Stiff				
15	5	SS	17	CL		(Glacial Drift)	4/9/10	17.7		*7000
						Grading Yellow Brown Very Stiff to Hard				
20	6	SS	18	CL		20 835.2	7/9/15	17.0		*8000
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: ALLSTATE CONSULTANTS LLC
DRILLING METHOD: MOBILE B47 WITH 7" HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/15/2020
COMPLETED: 10/15/2020 **BORING NO. 9**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 10

PROJECT: Proposed Middlebush Farm Building (CP191901)

CLIENT: The University of Missouri

SITE LOCATION: Tom Bass Road, Boone County, MO

PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 858.2				
						12" TOPSOIL				
	1	SS	17	CH		**FAT CLAY,** Tan Mottled Gray,	1/2/3	29.1		*2000
						3 Medium to Stiff, CH 855.2				
						LEAN CLAY,				
5	2	SS	15	CL		Gray Mottled Tan, Stiff, CL	2/3/5	22.2		*3500
						6 852.2				
	3	SS	18	CH		**FAT CLAY,** Trace Sand, Gray Mottled Tan, Stiff to Very Stiff, CH	2/3/4	23.5		*4000
10	4	SS	18	CH		Grading Stiff	2/2/3	24.7		*3500
						13 845.2				
15	5	SS	16	CL		**LEAN CLAY,** With Sand, Yellow Brown Mottled Gray, Very Stiff, CL	3/4/4	19.4		*5000
20	6	SS	18	CL		20 838.2	3/5/6	18.7		*6500
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.

DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS

DEPTH WATER FIRST ENCOUNTERED: NONE ▽

DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼

DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC

BORING **COLUMBIA, MISSOURI**

STARTED: 10/27/2020

COMPLETED: 10/27/2020 **BORING NO. 10**

LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 11

PROJECT: Proposed Middlebush Farm Building (CP191901)

CLIENT: The University of Missouri

SITE LOCATION: Tom Bass Road, Boone County, MO

PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 859.0				
						12" TOPSOIL				
	1	SS	14	CH		**FAT CLAY,** Brown Mottled Tan,	2/3/3	29.5		*4000
						3 Stiff to Very Stiff, CH 856.0				
5	2	SS	17	CL		**LEAN CLAY,** Gray Mottled Tan, Stiff, CL	3/4/4	20.7		*3500
	3	SS	18	CL			3/2/4	23.3		*3500
						8 851.0				
10	4	SS	18	CH		**FAT CLAY,** Trace Sand, Gray, Stiff to Very Stiff, CH	2/2/4	25.1		*4000
						13 846.0				
15	5	SS	18	CL		**LEAN CLAY,** With Sand, Yellow Brown, Very Stiff, CL	3/5/7	17.9		*7500
20	6	SS	18	CL		20 839.0	3/5/7	17.7		*7000
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.

DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS

DEPTH WATER FIRST ENCOUNTERED: NONE ▽

DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼

DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC

BORING **COLUMBIA, MISSOURI**

STARTED: 10/27/2020

COMPLETED: 10/27/2020 **BORING NO. 11**

LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 12

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 857.2		PL — LL (10 20 30 40 50 60)		
						12" TOPSOIL				
	1	3ST	14	CL		**LEAN CLAY,** Brown Mottled Orange,		PL 24, 29.0, LL 48	94	1250
						3 Medium, CL 854.2				
	2	3ST	16	CH		**FAT CLAY,**		PL 19, 28.4, LL 62	97	*3500
5						5 Gray Mottled Tan, Stiff, CH 852.2				
	3	3ST	17	CL		**LEAN CLAY,** Trace Silt, Gray, Stiff, CL		19.9	108	3360
						8 849.2				
	4	3ST	22	CH		**FAT CLAY,** Gray Mottled Tan, Stiff, CH		23.6	102	2610
10						13 844.2				
	5	SS	18	CL		**LEAN CLAY,** With Sand, Trace Gravel, Yellow Brown Mottled Gray, Very Stiff, CL	3/3/5	19.1		*5500
15										
	6	SS	17	CL		20 837.2	3/5/7	17.2		*6500
20						**BOTTOM OF BORING AT 20 FT.**				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/28/2020
COMPLETED: 10/28/2020 **BORING NO. 12**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 13

PROJECT: Proposed Middlebush Farm Building (CP191901)

CLIENT: The University of Missouri

SITE LOCATION: Tom Bass Road, Boone County, MO

PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 869.9				
						12" TOPSOIL				
	1	SS	13	CL		**LEAN CLAY,**	4/7/8	● 16.3		*9000+
						3 Brown, Hard, CL 866.9				
						FAT CLAY, Gray Mottled Tan,				
5	2	SS	13	CH		5 Very Stiff, CH 864.9	3/3/4	● 26.4		*6000
						BOTTOM OF BORING AT 5 FT.				

10 15 20 25 30 35

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: ALLSTATE CONSULTANTS LLC

DRILLING METHOD: MOBILE B47 WITH 7" HOLLOW STEM AUGERS

DEPTH WATER FIRST ENCOUNTERED: NONE ▽

DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼

DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC

BORING **COLUMBIA, MISSOURI**

STARTED: 10/15/2020

COMPLETED: 10/15/2020 **BORING NO. 13**

LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 14

PROJECT: Proposed Middlebush Farm Building (CP191901)

CLIENT: The University of Missouri

SITE LOCATION: Tom Bass Road, Boone County, MO

PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 866.2				
						12" TOPSOIL				
	1	SS	9	CH		**FAT CLAY,** Tan Mottled Gray,	4/5/7	● 23.7		*9000+
						3 Hard, CH 863.2				
						LEAN CLAY, Gray Mottled Tan,				
5	2	SS	18	CL		5 Very Stiff, CL 861.2	4/5/7	● 23.7		*5000
						BOTTOM OF BORING AT 5 FT.				
10										
15										
20										
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: ALLSTATE CONSULTANTS LLC

DRILLING METHOD: MOBILE B47 WITH 7" HOLLOW STEM AUGERS

DEPTH WATER FIRST ENCOUNTERED: NONE ▽

DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼

DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC

BORING **COLUMBIA, MISSOURI**

STARTED: 10/15/2020

COMPLETED: 10/15/2020 **BORING NO. 14**

LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 15

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 859.4				
						12" TOPSOIL				
	1	SS	9	CH		**FAT CLAY,** Trace Silt,	5/6/10	19.0		*9000+
						3 Tan Mottled Brown, Hard, CH 856.4				
						LEAN CLAY, Gray Mottled Tan,				
5	2	SS	15	CL		5 Very Stiff, CL 854.4	7/7/9	18.0		*7500
						BOTTOM OF BORING AT 5 FT.				
10										
15										
20										
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: ALLSTATE CONSULTANTS LLC
DRILLING METHOD: MOBILE B47 WITH 7" HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/15/2020
COMPLETED: 10/15/2020 **BORING NO. 15**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 16

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 851.1				
						12" TOPSOIL				
	1	SS	12	CL		**LEAN CLAY,** Brown Mottled Tan,	2/5/6	● 21.8		*5000
						3 Very Stiff, CL 848.1				
						FAT CLAY, Gray Mottled Tan,				
5	2	SS	12	CH		5 Very Stiff, CH 846.1	3/3/5	● 22.4		*5500
						BOTTOM OF BORING AT 5 FT.				

10 15 20 25 30 35

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: ALLSTATE CONSULTANTS LLC
DRILLING METHOD: MOBILE B47 WITH 7" HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/15/2020
COMPLETED: 10/15/2020 **BORING NO. 16**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 17

PROJECT: Proposed Middlebush Farm Building (CP191901)

CLIENT: The University of Missouri

SITE LOCATION: Tom Bass Road, Boone County, MO

PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 855.6				
						12" TOPSOIL				
	1	SS	6	CH		FAT CLAY, Brown, Very Stiff, CH	3/3/5	● 23.8		*9000
						3 852.6				
5	2	SS	18	CL		LEAN CLAY, Gray Mottled Orange, Very Stiff, CL 5 850.6	3/3/4	● 22.1		*5500
						BOTTOM OF BORING AT 5 FT.				

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.

DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS

DEPTH WATER FIRST ENCOUNTERED: NONE ▽

DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼

DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC

BORING **COLUMBIA, MISSOURI**

STARTED: 10/27/2020

COMPLETED: 10/27/2020 **BORING NO. 17**

LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 18

PROJECT: Proposed Middlebush Farm Building (CP191901)

CLIENT: The University of Missouri

SITE LOCATION: Tom Bass Road, Boone County, MO

PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 853.5				
						12" TOPSOIL				
	1	SS	8	CH		FAT CLAY, Brown Mottled Tan,	3/4/5	20.2		*9000
						3 Hard, CH 850.5				
						LEAN CLAY, Gray Mottled Tan,				
5	2	SS	15	CL		5 Very Stiff to Hard, CL 848.5	3/4/5	17.5		*8000
						BOTTOM OF BORING AT 5 FT.				

10 15 20 25 30 35

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.

DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS

DEPTH WATER FIRST ENCOUNTERED: NONE ▽

DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼

DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC

BORING **COLUMBIA, MISSOURI**

STARTED: 10/28/2020

COMPLETED: 10/28/2020 **BORING NO. 18**

LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 19

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 856.0				
						12" TOPSOIL				
	1	SS	4	CL		LEAN CLAY, Gray, Stiff, CL	3/3/3			*3000
						Grading Gray Mottled Tan,				
5	2	SS	13	CL		5 Very Stiff 851.0	2/3/4	20.1		*5000
						BOTTOM OF BORING AT 5 FT.				
10										
15										
20										
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/28/2020
COMPLETED: 10/28/2020 **BORING NO. 19**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 20

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 861.3				
						12" TOPSOIL				
	1	SS	12	CH		FAT CLAY, Gray Mottled Orange,	3/3/5	25.6		*7500
						3 Very Stiff, CH 858.3				
						LEAN CLAY, Gray Mottled Tan,				
5	2	SS	16	CL		5 Very Stiff, CL 856.3	3/3/6	21.8		*5500
						BOTTOM OF BORING AT 5 FT.				
10										
15										
20										
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/27/2020
COMPLETED: 10/27/2020 **BORING NO. 20**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 21

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 869.5				
						12" TOPSOIL				
	1	SS	8	CL		LEAN CLAY, Brown, Hard, CL	5/5/8	18.7		*9000+
						With Silt,				
5	2	SS	14	CL		5 Gray Mottled Brown 864.5	9/12/13	18.0		*9000+
						BOTTOM OF BORING AT 5 FT.				

10 15 20 25 30 35

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: ALLSTATE CONSULTANTS LLC
DRILLING METHOD: MOBILE B47 WITH 7" HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/15/2020
COMPLETED: 10/15/2020 **BORING NO. 21**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 22

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 863.4				
						12" TOPSOIL				
	1	SS	12	CH		**FAT CLAY,** Tan Mottled Orange,	4/5/9	● 21.9		*9000+
						3 Hard, CH 860.4				
						LEAN CLAY, Gray Mottled Orange,				
5	2	SS	18	CL		5 Very Stiff, CL 858.4	2/3/5	● 21.2		*5500
						BOTTOM OF BORING AT 5 FT.				
10										
15										
20										
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/28/2020
COMPLETED: 10/28/2020 **BORING NO. 22**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 23

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 869.3				
						12" TOPSOIL				
	1	SS	10	CL		LEAN CLAY,	3/4/5	19.4		*5500
						3 Brown, Very Stiff, CL 866.3				
						FAT CLAY, Gray Mottled Orange,				
5	2	SS	17	CH		5 Very Stiff, CH 864.3	4/8/10	23.2		*6500
						BOTTOM OF BORING AT 5 FT.				
10										
15										
20										
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: ALLSTATE CONSULTANTS LLC
DRILLING METHOD: MOBILE B47 WITH 7" HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/15/2020
COMPLETED: 10/15/2020 **BORING NO. 23**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 24

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 853.5				
						12" TOPSOIL				
	1	SS	7	CH		**FAT CLAY,** Brown, Hard, CH	4/6/5	20.3		*9000+
						3 850.5				
						LEAN CLAY, Trace Silt, Gray, Hard, CL				
5	2	SS	18	CL		5 848.5	2/5/6	19.9		*8500
						FAT CLAY, Trace Sand,				
	3	SS	18	CH		Gray Mottled Tan, Very Stiff, CH	3/2/4	21.4		*6000
						8 845.5				
						LEAN CLAY, With Sand,				
10	4	SS	18	CL		Yellow Brown Mottled Gray,	2/4/5	20.8		*8000
						Very Stiff to Hard, CL				
15	5	SS	18	CL			3/4/5	17.4		*8000
20	6	SS	18	CL		20 833.5	3/6/7	17.7		*8000
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/26/2020
COMPLETED: 10/26/2020 **BORING NO. 24**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG
BORING NO. 25

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 856.6				
						12" TOPSOIL				
	1	SS	12	CH		FAT CLAY, Tan Mottled Gray,	3/5/6	26.2		*8500
						3 Hard, CH 853.6				
5	2	SS	13	CL		LEAN CLAY, Gray Mottled Tan, Stiff, CL	3/3/4	21.0		*3500
	3	SS	18	CL		Grading Very Stiff	3/3/5	20.4		*5500
						8 848.6				
10	4	SS	18	CH		FAT CLAY, Trace Sand, Gray Mottled Tan, Very Stiff, CH	2/3/5	21.7		*5000
						13 843.6				
15	5	SS	18	CL		LEAN CLAY, With Sand, Yellow Brown, Very Stiff, CL	2/5/6	19.0		*6500
	6	SS	18	CL		Grading Stiff	3/6/8	17.1		*3500
20						20 836.6				
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/27/2020
COMPLETED: 10/27/2020 **BORING NO. 25**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 26

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 857.9				
						12" TOPSOIL				
	1	SS	12	CL		**LEAN CLAY,** Brown, Very Stiff, CL	3/4/4	18.4		*4500
						3 854.9				
						FAT CLAY, Gray Mottled Tan,				
5	2	SS	18	CH		5 Medium to Stiff, CH 852.9	3/3/5	25.8		*2000
	3	SS	18	CL		**LEAN CLAY,** Tan Mottled Gray,	3/3/4	24.1		*4500
						8 Very Stiff, CL 849.9				
						FAT CLAY, Trace Sand,				
10	4	SS	18	CH		Stiff to Very Stiff, CH	3/3/5	23.8		*4000
						13 844.9				
						LEAN CLAY,				
15	5	SS	17	CL		Trace Sand & Gravel,	2/4/6	19.6		*5500
						Yellow Brown Mottled Gray,				
						Very Stiff, CL				
						Grading Hard				
20	6	SS	18	CL		20 837.9	3/7/8	17.3		*9000
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/27/2020
COMPLETED: 10/27/2020 **BORING NO. 26**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG

BORING NO. 27

PROJECT: Proposed Middlebush Farm Building (CP191901)
CLIENT: The University of Missouri
SITE LOCATION: Tom Bass Road, Boone County, MO
PROJECT NO: 20120.02

ALLSTATE CONSULTANTS

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT / FIELD WATER CONTENT / LIQUID LIMIT (PL, LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						Approx. Surface Elevation: 858.5				
						12" TOPSOIL				
	1	SS	9	CH		**FAT CLAY,** Tan Mottled Orange,	3/4/5	20.9		*6000
						3 Very Stiff, CH 855.5				
						LEAN CLAY,				
5	2	SS	16	CL		Gray Mottled Tan,	3/5/6	19.5		*7500
						Very Stiff, CL				
	3	SS	18	CL		Grading Stiff to Very Stiff	2/3/3	22.0		*4000
						8 850.5				
						FAT CLAY, Trace Sand,				
10	4	SS	18	CH		Tan Mottled Gray,	2/2/4	24.5		*4000
						Stiff to Very Stiff, CH				
						13 845.5				
						LEAN CLAY, With Sand,				
15	5	SS	18	CL		Yellow Brown Mottled Gray,	3/4/5	19.8		*6500
						Very Stiff, CL				
20	6	SS	17	CL		20 838.5	2/5/7	17.8		*7000
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock types based on visual classification. Petrographic analysis may indicate other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: PALMERTON & PARRISH, INC.
DRILLING METHOD: CME 550 WITH 4.25" I.D. HOLLOW STEM AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

ALLSTATE CONSULTANTS, LLC
BORING **COLUMBIA, MISSOURI**
STARTED: 10/28/2020
COMPLETED: 10/28/2020 **BORING NO. 27**
LOG APPROVED BY: CCM **PAGE 1 OF 1**

TEST BORING LOG NOTES

SAMPLE TYPE

3ST	SHELBY TUBE SAMPLE – Obtained by pushing a standard 3 inch OD thin-walled tube sampler using the hydraulic stroke of the drilling rig.
S S	SPLIT-SPOON SAMPLE – Obtained by driving a standard 2 inch OD by 1 3/8 inch ID split-barrel sampler during performance of a Standard Penetration Test (SPT).
C S	CONTINUOUS SAMPLE - Obtained by inserting a 3 inch OD by 2 ¼ ID continuous split-barrel sampler into the lead section of a hollow stem auger string and advancing the sampler with the hollow stem auger as the auger penetrates into the underlying soil.
N X	ROCK CORE SAMPLE - Obtained by coring the rock with an NX size core barrel and diamond bit. The NX size core is approximately 2 1/8 inches in diameter. An NQ size core is approximately 2 inches in diameter.

SOIL AND ROCK DESCRIPTIONS AND CLASSIFICATION

Soil samples are described and classified in general accordance with the Unified Soil Classification System (USCS) using visual-manual procedures. All USCS Group Letter Symbols and Group Names are based on visual-manual estimates except where accompanied by results of Atterberg limits tests and grain size analyses. A brief description of the USCS is attached.

Fine-grained soils are also described in terms of their consistency and coarse-grained soils in terms of their in-place relative density. For fine-grained soils, the consistency is based on the unconfined compressive strength (Table 1). For coarse-grained soils the relative density is related to the N value determined from the Standard Penetration Test (Table 2).

Rock strata penetrated by flight augers or rock bits and intermittently sampled with a split-barrel sampler are described and classified based on drilling performance and visual observation of disturbed samples. Rock cores may reveal other rock types.

Rock core samples, obtained with a core barrel and diamond bit, are visually described and classified based on lithology, bedding, structure, degree of weathering, and hardness. All rock descriptions and classifications are based on visual observations. Petrographic analyses may indicate other rock types. Rock core recovery is expressed as the ratio of the length of core recovered to the length of the core run. Rock Quality Designation (RQD) is the ratio of the total length of the pieces of core that are hard, sound and 4 inches or longer to the length of the core run. Both core recovery and RQD are expressed as a percentage.

Soil and rock strata, delineated on the boring log, represent the geotechnical engineer's interpretation of subsurface conditions at the boring location. The interpretation is developed from the field boring log with modifications based on the laboratory test results and visual observations of the soil and rock samples. Graphical symbols depicting the soil and rock strata are shown on the boring logs for illustrative purposes. Different soil or rock types could be present between samples. A legend relating the graphical symbols to the USCS Group Letter Symbols and Group Names and the principal rock types encountered in the project area is attached. Stratification lines shown on the boring logs represent approximate boundaries between the various soil and rock types. In-situ, the transition between the soil and rock strata may be gradual.

STANDARD PENETRATION TEST

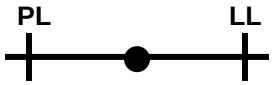
A standard split-barrel sampler (2 inch OD by 1 3/8 inch ID) is driven 18 inches into the soil by a 140 pound hammer repeatedly dropped from a height of 30 inches. The hammer blows are recorded for each 6 inches of penetration and the penetration resistance or N Value is considered the number of blows required for the final 12 inches of sampler penetration. Blows per 6 inch interval are recorded as 8/18/23 etc. under the Test Boring Log heading *SPT Blow Counts*. Where the sampler penetrated less than 6 inches under 50 hammer blows for one of the intervals, the results are recorded as 8/18/50-3".

LABORATORY TEST RESULTS AND SYMBOLS

PLASTIC LIMIT (PL) - Water content at which a soil will just begin to crumble when rolled into a thread approximately 1/8 inch in diameter. Generally represents the water content below which the soil develops cracks upon significant deformation.

LIQUID LIMIT (LL) - Water content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of ½ inch under the impact of 25 blows in a standard liquid limit apparatus. Generally represents the water content above which the soil is in suspension and has minimal shear strength.

FIELD WATER CONTENT - Water content of the soil or rock at depth indicated at time of exploration. The water content may fluctuate with seasonal and climatological conditions and may be altered by excavation, exposure and other construction activities or by conditions not apparent during exploration.



- Relationship between plastic limit (PL), field water content, and liquid limit (LL). The plasticity index, (PI), is the difference between the liquid and plastic limits. In general, the higher the liquid limit and PI, the more a soil is inherently prone to volume change. However, soils with lower liquid limits and PI's can also experience volume change.

Soils having field water contents approaching the liquid limit typically have low shear strength and high compressibility. Soils having water contents near the plastic limit typically have higher shear strength and lower compressibility.

UNCONFINED COMPRESSIVE STRENGTH _ The load per unit area at which an unconfined cylindrical specimen of soil will fail in a simple, quick compression test without lateral support. Expressed in pounds per square foot on the boring log.

* Indicates unconfined compressive strength estimated using a calibrated hand penetrometer.

TABLE 1

CONSISTENCY OF FINE-GRAINED SOILS

UNCONFINED COMPRESSIVE STRENGTH, Qu, psf	CONSISTENCY
Less than 500 psf	Very Soft
500 - 1,000	Soft
1,000 - 2,000	Medium
2,000 - 4,000	Stiff
4,000 - 8,000	Very Stiff
Above - 8,000	Hard

TABLE 2

RELATIVE DENSITY OF COARSE-GRAINED SOILS

SPT N VALUE Blows/ft.	RELATIVE DENSITY
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
Above 50	Very Dense

TABLE 3

ROCK QUALITY DESIGNATION RQD

RQD (%)	ROCK QUALITY
0 - 25	Very Poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 – 100	Excellent

WATER LEVEL SYMBOLS AND OBSERVATIONS:

WS or WD - Borehole water level observation *While Sampling* or *While Drilling* - ▽ WCI - *Wet Cave In*

AB - Borehole water level observation *After Boring* completion - ▼ DCI - *Dry Cave In*

24 Hrs AB – Water level observation *24 Hrs After Boring* completion - ▼
or other such time as recorded on the boring log.

Borehole water level measurements were made at the times and under the conditions indicated on the boring logs. Groundwater levels may vary across the site and will fluctuate with seasonal and climatological conditions. Groundwater levels may also be altered by site grading and/or other construction activities. Borehole water level measurements in highly pervious soils may represent groundwater conditions in these units at the time of the observations. In semi-pervious and fine-grained soils, short term water level measurements in borings may not represent actual groundwater conditions. Long term observations of piezometers, screened in the hydrologic units of interest, and sealed from the influence of surface water are typically required to evaluate groundwater conditions and fluctuations in groundwater levels in low permeability soils.

SOIL AND ROCK SYMBOLS FOR BORING LOGS

SOIL SYMBOLS

GRAPHICAL SYMBOL	USCS Group Symbol	USCS Group Name
	GW	Well–graded gravel
	GP	Poorly graded gravel
	GM	Silty gravel
	GC	Clayey gravel
	SW	Well–graded sand
	SP	Poorly graded sand
	SM	Silty sand
	SC	Clayey sand
	CL	Lean clay
	ML	Silt
	CL–ML	Silty Clay
	OL	Organic clay / Organic silt
	CH	Fat clay
	MH	Elastic silt
	OH	Organic clay / Organic silt
	PT	Peat

ROCK SYMBOLS

GRAPHICAL SYMBOL	MAJOR ROCK TYPE
	SILTSTONE
	SHALE
	SANDSTONE
	LIMESTONE
	DOLOMITE
	COAL
	UNDERCLAY
	CLAYSTONE

OTHER SYMBOLS

CL	Lean Clay, with Sand and Gravel (Glacial Drift)
CH	Fat Clay, with Sand and Gravel (Glacial Drift)

ALLSTATE CONSULTANTS
3312 LEMONE INDUSTRIAL BLVD.
COLUMBIA, MO. 65201
(573) 875-8799
ENGINEERING • PLANNING • SURVEYING • GEOTECHNICAL • INVESTIGATIVE

UNIFIED SOIL CLASSIFICATION SYSTEM

Soil Classification Chart

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	**Silts and Clays Liquid limit less than 50**	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit – oven dried / Liquid limit – not dried < 0.75	OL	Organic clay[K,L,M,N] / Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	Liquid limit – oven dried / Liquid limit – not dried < 0.75	OH	Organic clay[K,L,M,P] / Organic silt[K,L,M,Q]
HIGHLY ORGANIC SOILS		Primarily organic matter, dark in color, and organic odor		PT	Peat

Footnotes

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains $\geq$ 30% plus No. 200, predominantly sand, add "sandy" to group name.

[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI $\geq$ 4 and plots on or above "A" line.

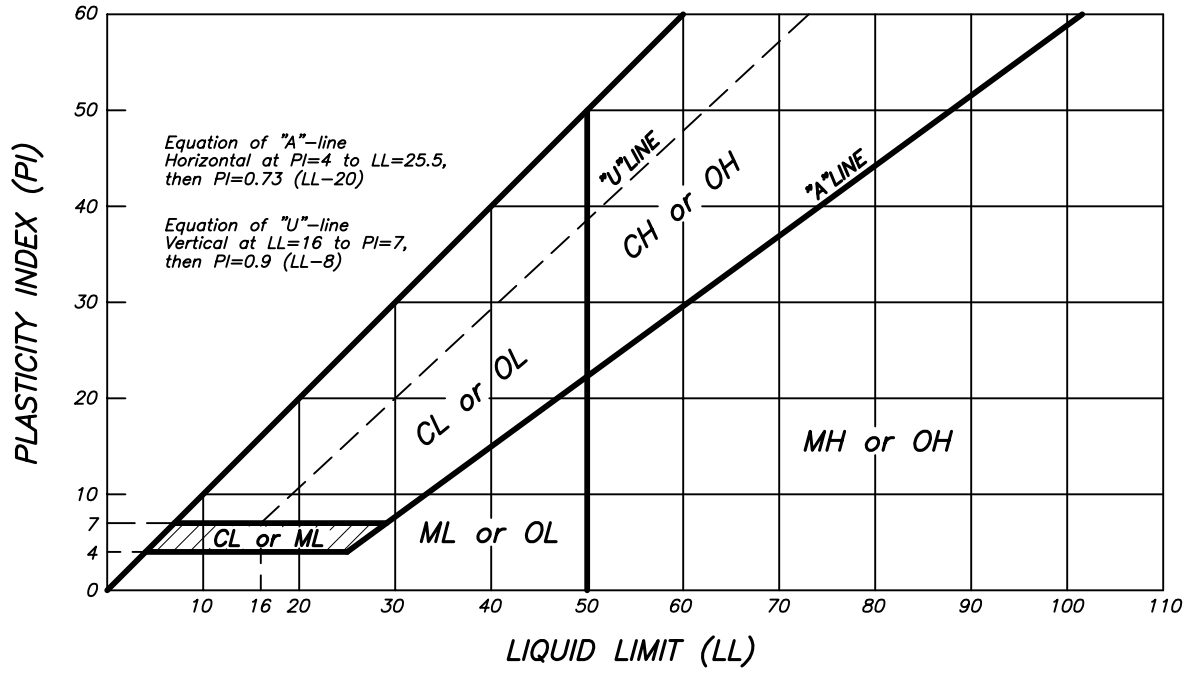
[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

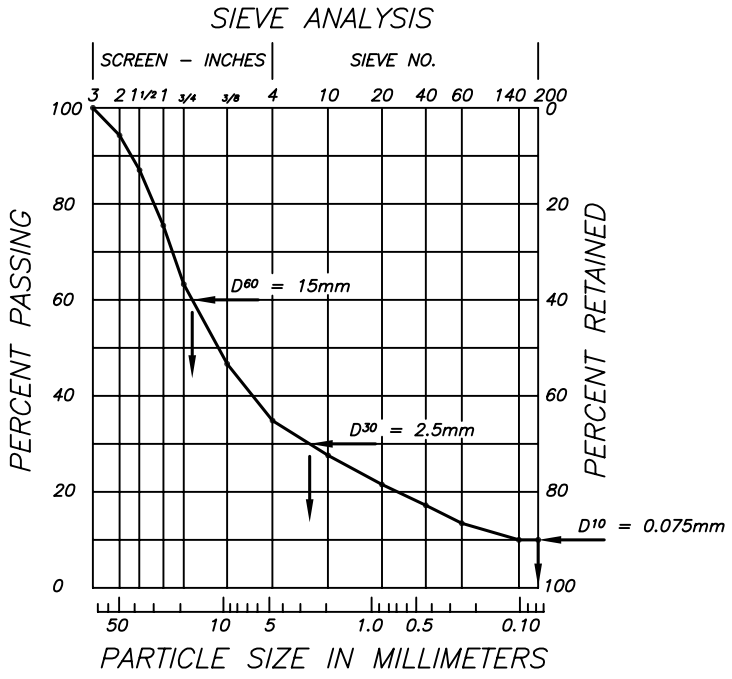
[Q] PI plots below "A" line.

ALLSTATE CONSULTANTS
3312 LEMONE INDUSTRIAL BLVD.
COLUMBIA, MO. 65201
(573) 875-8799
ENGINEERING • PLANNING • SURVEYING • GEOTECHNICAL • INVESTIGATIVE

UNIFIED SOIL CLASSIFICATION SYSTEM



PLASTICITY CHART FOR CLASSIFICATION OF FINE–GRAINED SOILS AND FINE–GRAINED FRACTION OF COARSE–GRAINED SOILS.



$Cu = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200$

$Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$

Cumulative Particle–Size Plot

FOR CLASSIFICATION OF COARSE–GRAINED SOILS WITH 12% OR LESS FINES.

ALLSTATE CONSULTANTS
3312 LEMONE INDUSTRIAL BLVD.
COLUMBIA, MO 65201
(573) 875-8799
ENGINEERING • PLANNING • SURVEYING • GEOTECHNICAL • INVESTIGATIVE

LABORATORY SWELL TEST REPORT

Allstate Consultants, LLC
3312 LeMone Industrial Blvd.
Columbia, Missouri 65201
(573) 875-8799

ALLSTATE CONSULTANTS

Client: University of Missouri
Project: Proposed Middlebush Farms Building and Parking Lot (CP191901)
Location: Tom Bass Road, Columbia, MO

Report Date: November 10, 2020
Project No.: 20120.02

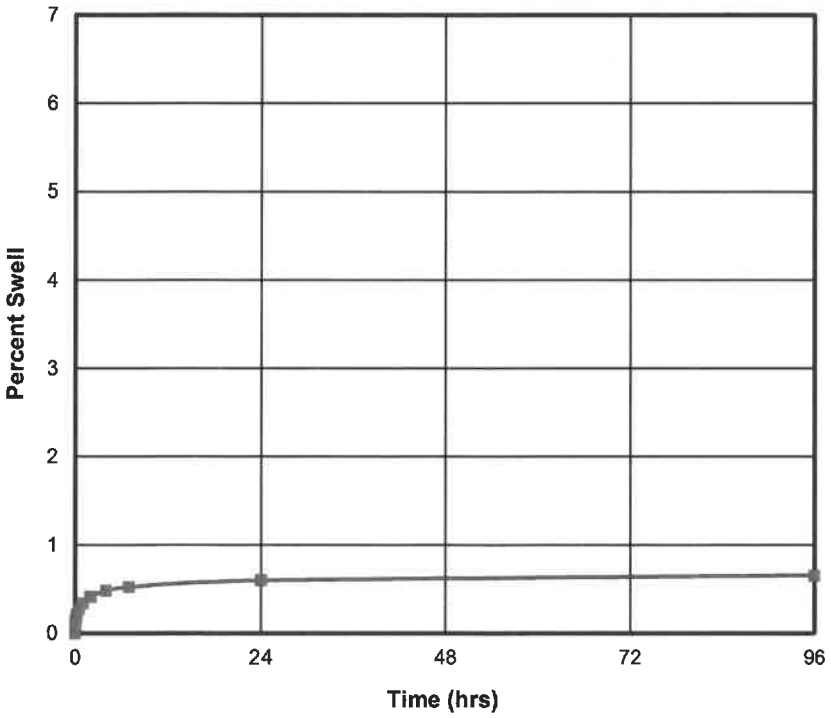
MATERIAL INFORMATION

Boring No.: TB-1 **Date:** November 5, 2020
Sample No.: ST-1
Depth: 1' - 3'
Description: FAT CLAY, With Roots, Trace Gravel, Gray Mottled Brown, Hard, CH

TEST INFORMATION

Test Method: ASTM D 4546
Test Procedure: Method B (Modified)
Sample Preparation: Undisturbed

LABORATORY TEST RESULTS



SWELL
0.7 %
SURCHARGE PRESSURE
750 PSF

Sample Diameter (in):	2.48
Sample Height (in):	0.93
Initial Moisture Content (%):	21.5
Initial Dry Density (pcf):	104.7
Final Moisture Content (%):	26.0
Final Dry Density (pcf);	105.5

Atterberg Limits

Liquid limit:	(LL)	54
Plastic limit:	(PL)	20
Plasticity Index:	(PI)	34

USCS Classification
Group Symbol: CH

Comments:

Reviewed by:

Cassidy Mathews, P.E.
Geotechnical Manager

LABORATORY SWELL TEST REPORT

Allstate Consultants, LLC
3312 LeMone Industrial Blvd.
Columbia, Missouri 65201
(573) 875-8799

ALLSTATE CONSULTANTS

Client: University of Missouri
Project: Proposed Middlebush Farms Building and Parking Lot (CP191901)
Location: Tom Bass Road, Columbia, MO

Report Date: November 9, 2020
Project No.: 20120.02

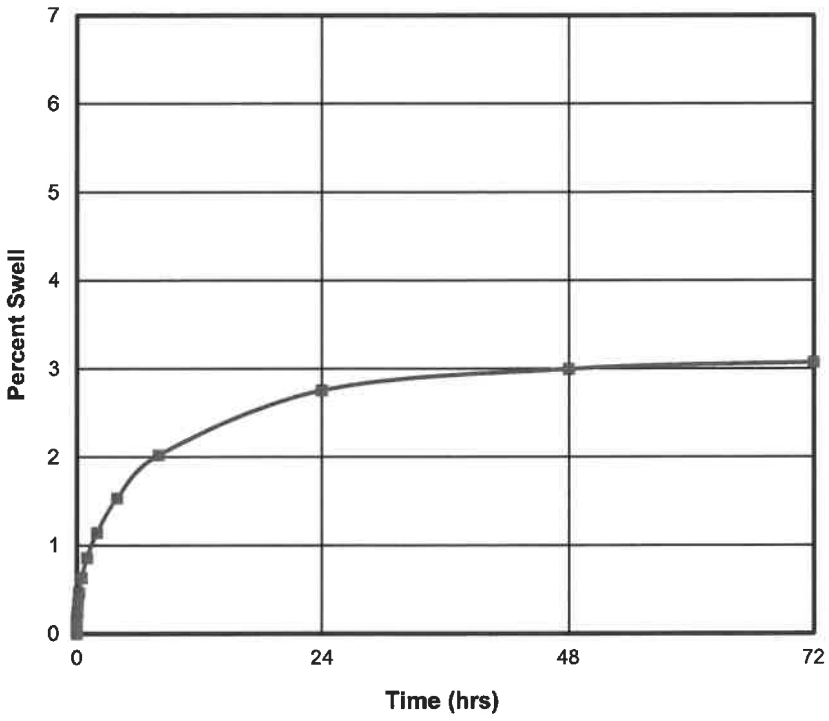
MATERIAL INFORMATION

Boring No.: TB-6
Sample No.: ST-1
Depth: 1' - 3'
Date: November 3, 2020
Description: LEAN CLAY, Trace Roots, Trace Gravel, Gray Mottled Tan, Hard, CL

TEST INFORMATION

Test Method: ASTM D 4546
Test Procedure: Method B (Modified)
Sample Preparation: Undisturbed

LABORATORY TEST RESULTS



SWELL
3.1 %
SURCHARGE PRESSURE
125 PSF

Sample Diameter (in):	2.49
Sample Height (in):	0.95
Initial Moisture Content (%):	16.6
Initial Dry Density (pcf):	115.0
Final Moisture Content (%):	20.8
Final Dry Density (pcf);	111.7

Atterberg Limits

Liquid limit:	(LL)	47
Plastic limit:	(PL)	19
Plasticity Index:	(PI)	28

USCS Classification
Group Symbol: CL

Comments:

Reviewed by:

Cassidy Mathews, P.E.
Geotechnical Manager

LABORATORY SWELL TEST REPORT

Allstate Consultants, LLC
3312 LeMone Industrial Blvd.
Columbia, Missouri 65201
(573) 875-8799

ALLSTATE CONSULTANTS

Client:	University of Missouri	**Report Date:**	November 6, 2020
Project:	Proposed Middlebush Farms Building and Parking Lot (CP191901)	**Project No.:**	20120.02
Location:	Tom Bass Road, Columbia, MO		

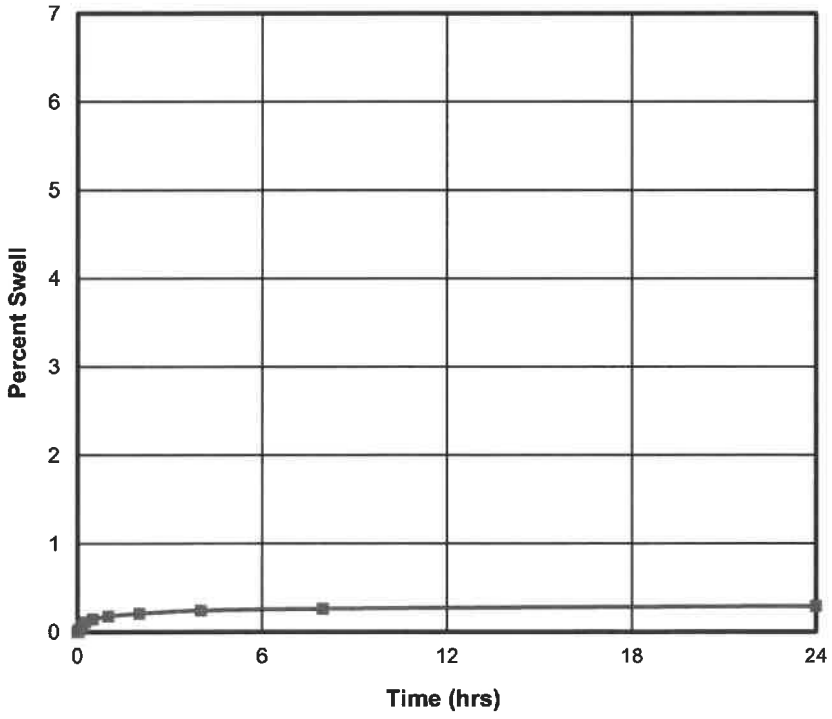
MATERIAL INFORMATION

Boring No.:	TB-6	**Date:**	November 3, 2020
Sample No.:	ST-2		
Depth:	3' - 5'		
Description:	LEAN CLAY, Trace Roots, Trace Gravel, Gray Mottled Tan, Hard, CL		

TEST INFORMATION

Test Method:	ASTM D 4546
Test Procedure:	Method B (Modified)
Sample Preparation:	Undisturbed

LABORATORY TEST RESULTS



SWELL
0.3 %
SURCHARGE PRESSURE
500 PSF

Sample Diameter (in):	2.49
Sample Height (in):	0.92
Initial Moisture Content (%):	17.4
Initial Dry Density (pcf):	117.6
Final Moisture Content (%):	19.0
Final Dry Density (pcf);	118.2

Atterberg Limits

Liquid limit:	(LL)	44
Plastic limit:	(PL)	17
Plasticity Index:	(PI)	27

USCS Classification
Group Symbol: CL

Comments:

Reviewed by:

Cassidy Mathews, P.E.
Geotechnical Manager

LABORATORY SWELL TEST REPORT

Allstate Consultants, LLC
3312 LeMone Industrial Blvd.
Columbia, Missouri 65201
(573) 875-8799

ALLSTATE CONSULTANTS

Client: University of Missouri
Project: Proposed Middlebush Farms Building and Parking Lot (CP191901)
Location: Tom Bass Road, Columbia, MO

Report Date: November 9, 2020
Project No.: 20120.02

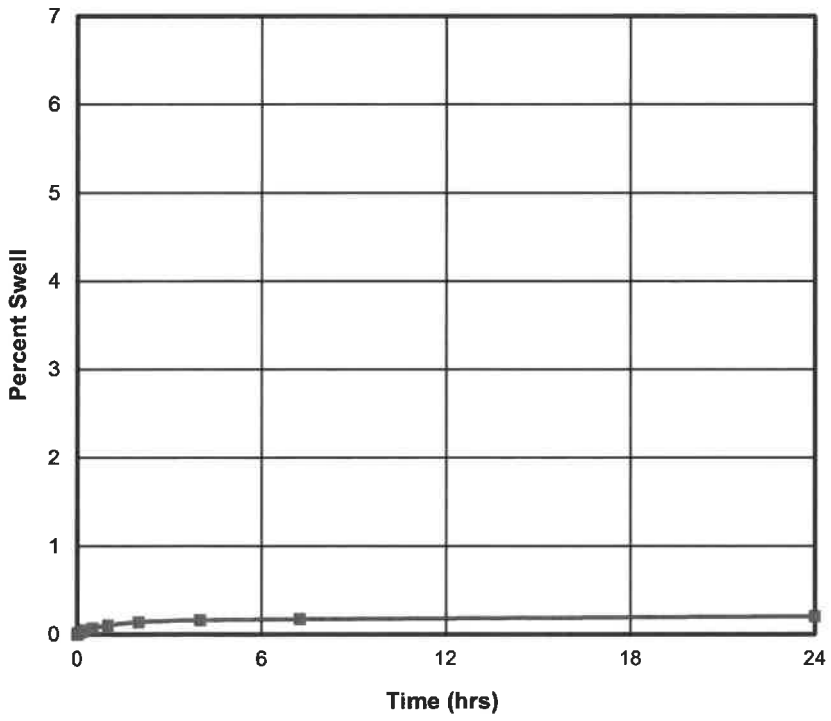
MATERIAL INFORMATION

Boring No.: TB-7
Sample No.: ST-1
Depth: 1' - 3'
Date: November 3, 2020
Description: FAT CLAY, Trace Roots, Brown Mottled Gray, Stiff, CH

TEST INFORMATION

Test Method: ASTM D 4546
Test Procedure: Method B (Modified)
Sample Preparation: Undisturbed

LABORATORY TEST RESULTS



SWELL
0.2 %
SURCHARGE PRESSURE
125 PSF

Sample Diameter (in):	2.48
Sample Height (in):	0.93
Initial Moisture Content (%):	29.5
Initial Dry Density (pcf):	95.8
Final Moisture Content (%):	31.4
Final Dry Density (pcf);	96.0

Atterberg Limits

Liquid limit:	(LL)	63
Plastic limit:	(PL)	25
Plasticity Index:	(PI)	38

USCS Classification
Group Symbol: CH

Comments:

Reviewed by:

Cassidy Mathews, P.E.
Geotechnical Manager

LABORATORY SWELL TEST REPORT

Allstate Consultants, LLC
3312 LeMone Industrial Blvd.
Columbia, Missouri 65201
(573) 875-8799

ALLSTATE CONSULTANTS

Client: University of Missouri
Project: Proposed Middlebush Farms Building and Parking Lot (CP191901)
Location: Tom Bass Road, Columbia, MO

Report Date: November 9, 2020
Project No.: 20120.02

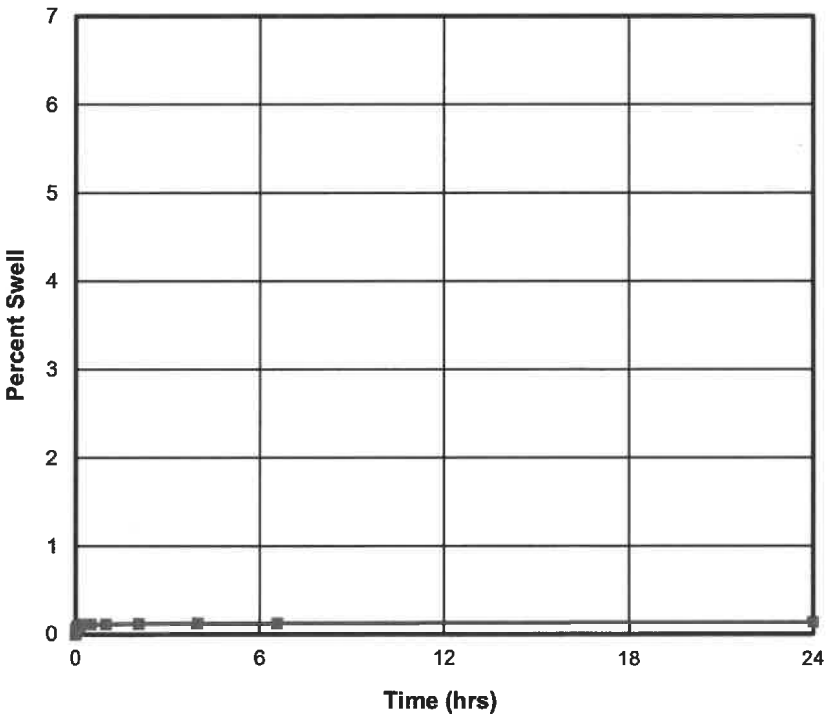
MATERIAL INFORMATION

Boring No.: TB-12
Sample No.: ST-1
Depth: 1' - 3'
Date: November 3, 2020
Description: LEAN CLAY,With Roots, Brown Mottled Gray, Stiff, CL

TEST INFORMATION

Test Method: ASTM D 4546
Test Procedure: Method B (Modified)
Sample Preparation: Undisturbed

LABORATORY TEST RESULTS



SWELL
0.1 %
SURCHARGE PRESSURE
125 PSF

Sample Diameter (in):	2.49
Sample Height (in):	0.96
Initial Moisture Content (%):	28.1
Initial Dry Density (pcf):	94.7
Final Moisture Content (%):	29.3
Final Dry Density (pcf);	94.9

Atterberg Limits

Liquid limit:	(LL)	48
Plastic limit:	(PL)	24
Plasticity Index:	(PI)	24

USCS Classification
Group Symbol: CL

Comments:

Reviewed by:

Cassidy Mathews, P.E.
Geotechnical Manager

LABORATORY SWELL TEST REPORT

Allstate Consultants, LLC
3312 LeMone Industrial Blvd.
Columbia, Missouri 65201
(573) 875-8799

ALLSTATE CONSULTANTS

Client:	University of Missouri	**Report Date:**	November 10, 2020
Project:	Proposed Middlebush Farms Building and Parking Lot (CP191901)	**Project No.:**	20120.02
Location:	Tom Bass Road, Columbia, MO		

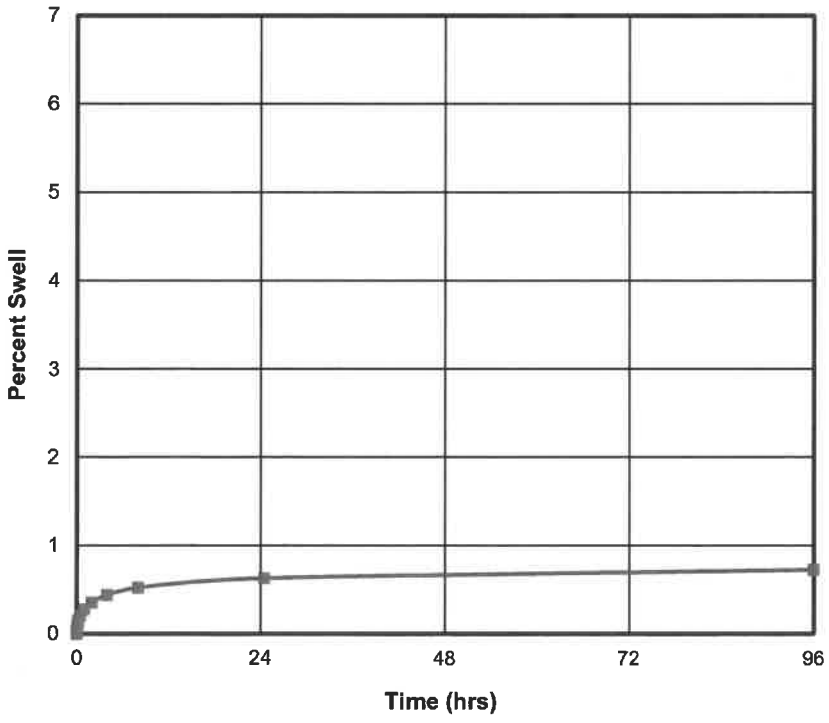
MATERIAL INFORMATION

Boring No.:	TB-12	**Date:**	November 5, 2020
Sample No.:	ST-2		
Depth:	3' - 5'		
Description:	FAT CLAY, Trace Roots & Gravel, Gray Mottled Tan, Stiff, CH		

TEST INFORMATION

Test Method:	ASTM D 4546
Test Procedure:	Method B (Modified)
Sample Preparation:	Undisturbed

LABORATORY TEST RESULTS



SWELL
0.7 %
SURCHARGE PRESSURE
500 PSF

Sample Diameter (in):	2.49
Sample Height (in):	0.92
Initial Moisture Content (%):	27.6
Initial Dry Density (pcf):	103.1
Final Moisture Content (%):	28.6
Final Dry Density (pcf);	103.2

Atterberg Limits

Liquid limit:	(LL)	62
Plastic limit:	(PL)	19
Plasticity Index:	(PI)	43

USCS Classification
Group Symbol: CH

Comments:

Reviewed by:

Cassidy Mathews, P.E.
Geotechnical Manager

SECTION 015713
TEMPORARY EROSION AND SEDIMENT CONTROL AND SWPPP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Silt fence erosion protection.
   2. Hay bale silt fence erosion protection.
   3. Storm Water Pollution Prevention Plan (SWPPP) included in this project manual is part of the contract and Contractor is responsible for all items indicated therein.

B. Related Sections:
   1. Section 311000 – Site Clearing.
   2. Section 312000 – Earth Moving.
   3. Section 329119 – Landscape Grading.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements;
   1. Comply with all requirements, exemptions, regulations and outflow sampling requirements set forth by local and state agencies.

PART 2 PRODUCTS

2.01 MATERIALS

A. Straw Bale Fence: As indicated on Drawings.

B. Silt Fence Fabric: Synthetic filter fabric or a pervious sheet of polypropylene, nylon, polyester, or polyethylene yard, containing ultraviolet ray inhibitors and stabilizers providing a minimum of six months usable construction life at a temperature range from 0 to 120 degrees F., and meeting the following requirements:
   1. Sediment retention efficiency: Not less than 85 percent.
   2. Grab strength at 20 percent maximum elongation:
      a. Standard strength fabric: 30 pounds per lineal inch.
      b. Extra strength fabric: 50 pounds per lineal inch.
   3. Flow rate: Not less than 0.30 gallons per square foot per minute.

C. Silt Fence Posts: Contractor has option of the following:
   1. 4 inch diameter pine.
   2. 2 inch diameter pine.
   3. 1.33 pound per lineal foot steel posts a minimum of 4 feet in length.
      a. Steel posts shall have projections for fastening the fabric.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion:
   1. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection:
   1. Protect trees, shrubs, lawns, other vegetation and other features indicated on Drawings to remain, or not indicated to be removed.
      a. Provide temporary guards to protect trees and vegetation which is to remain.

b. Protect roots over 1-1/2 inch diameter which are cut during construction operations.
   1) Coat cut faces with emulsified asphalt or other acceptable coating formulated for use on damaged plan tissues.
   2) Temporarily cover exposed roots with wet burlap to prevent roots from drying out. Cover with earth as soon as possible.

2. Protect bench marks, monuments, existing structures, existing fences, existing roads, existing sidewalks, existing paving, existing curbs and other features indicated on Drawings to remain, or not indicated to be removed, from damage and displacement.
   a. If damaged or displaced, notify Engineer and correct defects as directed by Engineer.
3. Protect above and below grade utilities which are to remain.

B. Preparation:
1. Use all means necessary to control dust on and near the Work, and on and near off-site storage, and spoil areas, if such dust is caused by performance of the Work of this Section, or if resulting from the condition in which Project Site is left by Contractor..
2. Moisten surfaces as required to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other Work on Project Site.

3.03 INSTALLATION

A. Install erosion control devices at locations indicated on Drawings, and where required to protect adjacent and downstream properties from damage and pollution resulting from erosion caused by the Work of this Contract.
1. Implement erosion control measures indicated on Drawings and additional erosion control measures necessary to prevent damage to adjacent and downstream properties.

B. Install silt fence located along perimeter of Site or grading limits immediately following site clearing operations specified under Section 311000.
1. Install silt fence fabric from a continuous roll for the length of the silt fence whenever possible to minimize the number of joints.
   a. Create joints in fabric by securely fastening fabric at the support post with overlap extending to the next post.
2. Drive support post into ground not less than 18 inches.
3. Excavate a 4 inch wide by 8 inch deep trench on up-slope side of silt fence.
   a. Line trench with silt fence fabric materials.
   b. Backfill trench with soil or gravel.

C. Install straw bale fence at completion of grading operations in affected area.
1. Install erosion control devices at storm sewer inlets immediately after completion of the storm sewer.
2. Place straw bales in a single row, lengthwise on the contour, and embedded 4 inches into soil.
3. Secure each individual bale in place by stakes or reinforcement bars driven through bales into the ground to a depth not less than 18 inches.

3.04 MAINTENANCE

A. Check silt fences and straw bale fences after each rainfall event to ensure that they are in proper working order:
1. Check embankments and spillways for erosion, settlement or other damage.
2. Immediately make all necessary repairs.

B. Inspect silt and straw bale fences at least once a week.

1. Immediately replace damaged portions of the silt fences, including portions which have collapsed, contain tears, have decomposed, or have become ineffective.

C. Remove sediment deposits as necessary to provide adequate sediment storage and to maintain the integrity of fences.

D. Maintain erosion control devices in places as specified until Site is stabilized by pavement, vegetation, or other means.

E. After site is stabilized, remove erosion control devices, sediment, and debris from Site prior to final grading specified under Section 312000 and Section 329119.

3.05 SWPPP

A. A Storm Water Pollution Prevention Plan (SWPPP), follows this section.

B. The General Contractor shall be responsible for meeting the requirements of the SWPPP and the land disturbance plans.

C. SWPPP Coordinator shall be the Contractor or someone hired by the Contractor.

D. The Coordinator shall be responsible for the inspection and maintenance of the erosion control measures in accordance with the SWPPP.

E. Contractor shall be responsible for employee training per the SWPPP.

F. Notification to All Contractors: The permittee shall be responsible for notifying each contractor or entity (including utility crews and city employees or their agents) who will perform work at the site of the existence of the SWPPP and what action or precautions shall be taken while on-site to minimize the potential for erosion and the potential for damaging any BMP. The SWPPP shall contain a list of contractors or entities that have been notified. The permittee is responsible for any damage a subcontractor may do to established BMPs and any subsequent water quality violation resulting from damage.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

University of Missouri - Columbia
Middlebush Nextgen Center of Excellence for Influenza Research – Phase II
CP# 230831

Columbia, Missouri

NPDES Storm Water Pollution Prevention Plan for
Storm Water Discharges Associated with
Construction Activity

SK Design Group, Inc.

December 2024

Table of Contents

1.0 Purpose of Plan 1

2.0 Site Evaluation 1
- 2.0 Project Information 1
- 2.1 Topography and Drainage 1
- 2.2 Soils 1
- 2.3 Runoff Water Quality 2
- 2.4 Receiving Waters 2
- 2.5 Buffer Exception 2

3.0 Site Construction Plan 2
- 3.1 Construction Activities 2
- 3.2 Construction Sequence 2

4.0 Storm Water Management Plan 2
- 4.1 General Description of Storm Water Management System 3
- 4.2 Runoff Coefficient 3
- 4.3 Project Site 3
  - 4.3.1 Stabilization Practices 3
  - 4.3.2 Structural Practices 3

5.0 Potential Storm Water Pollutant Sources and Control Measures 4
- 5.1 Construction Silt and Dust 4
- 5.2 Offsite Sediment Tracking 4
- 5.3 Petroleum Products 4
- 5.4 Sanitary Wastes 5
- 5.5 Hazardous Wastes 5
- 5.6 Fertilizers 5
- 5.7 Paints 5
- 5.8 Concrete Trucks 5
- 5.9 Waste Materials 5
- 5.10 Allowable Non-Storm Water Discharges 6

6.0 Best Management Practices 6
- 6.1 Good Housekeeping 6
- 6.2 Hazardous Materials 6
- 6.3 Spill Prevention and Response 7

7.0 Inspection, Maintenance, and Reporting Procedures 7
- 7.1 Erosion and Sediment Control 7
- 7.2 Non-Storm Water Controls 8
- 7.3 Reporting 8
  - 7.3.1 Inspection Form 1: Erosion and Sedimentation Controls 10
  - 7.3.2 Inspection Form 2: Non-Storm Water Source Controls 11

8.0 Certification of Compliance 13
- 8.1 Contractor Certifications 13

9.0 Project Completion 13

10.0 References 13

11.0 Appendix A: Project Location Map 14

12.0 Appendix B: USDA Soil Report 17

13.0 Appendix C: SWPPP Details 44

14.0 Appendix D: SWPPP Site Plan 46

15.0 Appendix F: Construction Activity Record 48

16.0 Appendix G: Completed Inspection Forms 50

1.0 Purpose of Plan

The purpose of this Construction Storm Water Pollution Prevention Plan (Plan) is to demonstrate compliance with the requirements of the National Pollutant Discharge Elimination System (NPDES) for General Permit MOR 100039 for storm water discharges associated with construction activity. The General Permit requires the preparation and implementation of such a plan to prevent, as much as practicable, the release of pollutants in storm water runoff from the construction site to waters of the United States.

This Plan provides information about the University of Missouri CP #230831 project located in Columbia, Missouri. Administrative requirements and potential storm water and non-storm water pollutant sources are identified. Best management practices to prevent the discharge of non-storm water materials in storm water runoff are also described.

The University of Missouri CP #230831 project site consists of approximately 5 acres of land located northeast of the intersection of University Lane and the future extension of Discovery Ridge. The future extension of Discovery Ridge is approximately 300' north of E Sugar Grove Road at the location of the site. The site is in Columbia, Missouri. This SWPPP addresses construction of the Swine Research Facility with site/utility improvements and disturbs approximately 2.5. A project location map is attached as Exhibit 1.

Site Evaluation

2.0 Project Information

Project Name and Location: CP #230831, Columbia, Missouri

MU Designated Representatives for Environmental Issues: Michael Stornello

Owner Name: University of Missouri Columbia

General Project Description: Construction of the South Farm Swine Research and Education Facility addition with site/utility improvements at the northeast corner of the intersection of University Lane and Discovery Ridge Parkway.

Project Location: Northeast of the intersection of University Lane and Discovery Ridge Parkway. Refer to Exhibit 1.

General Construction Activity Description: Grading, building construction, underground utility construction, drive and sidewalk construction.

2.1 Topography and Drainage

The topography of the existing property slopes from the west to the east of the site. There is approximately 4-6 feet of vertical relief between the west and east side of the site.

2.2 Soils

The soils on this project site were identified according to the Geotechnical Engineering Report for CP #230831. The soil in the area consists of a combination of silty clay and silty clay with sand and gravel.

2.3 Runoff Water Quality

No surface water quality data is available for the project site. However, due to the nature of the site runoff could be expected to contain some suspended solids.

2.4 Receiving Waters

The site is collected by a concrete flume on site and flows above ground to an unnamed tributary along the east side of the property. The unnamed tributary drains to the northeast, 0.52 miles to Grindstone Creek. See attached map of tributary in appendix A.

Section 404 Permit and associated 401 Water Quality Certification were considered but they are not applicable.

2.5 Buffer Exceptions

No natural buffer exists due to preexisting development disturbances that occurred prior to the initiation of planning for this project.

3.0 Site Construction Plan

The following sections describe the proposed development and the site construction plan.

3.1 Construction Activities

The project site will include construction of the South Farm Swine Research and Education Facility addition with gravel drive, sidewalk and utility improvements. The project will require pavement/utility demolition, soil removal, and site grading to support the planned development. Soil disturbing activities will include clearing, grubbing, and pavement/utility demolition. The project will have construction access off the existing gravel driveway around the Phase 1 building. The project construction traffic will utilize University Lane on the west side of the site. The contractor shall be responsible for minimizing soils tracked onto the surrounding roadway and their cleaning.

A record of the project site construction activities must be maintained as a part of this Plan. Appendix A includes a form and instructions to record such information on an ongoing basis.

3.2 Construction Sequence

The project will be constructed generally following the sequence indicated below.

Site Best Management Practices will be installed.
The site will be cleared and grubbed.
The site utilities and pavements will be constructed.
Remove BMP’s after site is stabilized.

4.0 Storm Water Management Plan

This storm water management plan was designed following EPA guidelines. Structural sediment control devices will be the main means of storm water management. Storm water sediment controls will be installed before any construction begins.
The proposed construction activities do not impact any Waters of the US and Section 404 Permit and associated Section 40 Water Quality Certifications are not required for the project.

4.1 General Description of Storm Water Management System

The potential for storm water runoff pollution will be present during construction of the site. This risk will be minimized through the use of several control measures implemented before and during the construction sequence.

The storm water management system was designed in accordance with the EPA's guidance document entitled *Storm Water Management for Construction Activities- Developing Pollution Prevention Plans And Best Management Practices* (EPA 832-R-92-005, September 1992). Structural measures are the main means of storm water management. Storm water control measures are described and shown on the Erosion Control Plan Drawing. This document is available at the USEPA internet site; and

The latest version of ***Protecting Water Quality: A field guide to erosion, sediment and storm water best management practices for development sites in Missouri***, published by the Missouri Department of Natural Resources. This manual is available on the department's internet site at: http://www.dnr.mo.gov.env/wpp/wpcp-guide.htm.

It will be the responsibility of the Construction Manager to revise the Erosion Control Plan Drawing if the location or types of control measures are changed in the field.

4.2 Runoff Coefficient

In determining the runoff coefficient for the project site the method described City of Columbia's Stormwater Management & Water Quality Manual. This method is based on the pavement areas and vegetative cover of both the existing and proposed conditions.

4.3 Project Site

The surface water management during construction will be through the use of silt fences, inlet protection and soil stabilization measures. Storm water will be conveyed by overland surface flow to silt fences or inlet protection. The silt fences or inlet protection will remove suspended solids before entering the public storm system.

4.3.1 Stabilization Practices

Temporary and permanent stabilization methods will be used on the project site. Two major stabilization methods that will be used on the site are preserving existing vegetation where possible and disturbing only the area needed for project construction. Disturbed portions of the site will be stabilized within 7 days after construction activity has temporarily or permanently ceased, with two exceptions –when snow cover precludes construction or construction will resume within 21 days. Stabilization practices may include temporary or permanent seeding,

mulching, geotextiles, sodding, or aggregate surfacing. Site access facilities (entrances/exits and parking areas) will be surfaced with aggregate to reduce sediment tracking.

4.3.2 Structural Practices

Temporary devices to divert, store, or limit runoff from disturbed areas will be used on the project site. Such devices may include silt fences, triangular silt dike and catch basin inlet protection. Details of the control measures are shown on the site plan, erosion control plans, and detail sheets (Appendix D)

Wash and/or rinse waters from concrete mixing equipment including ready mix concrete tracks shall be collected in a concrete washout with vehicle tracking control as shown on standard detail "ESC-01 construction entrance and concrete washout". Material from the concrete washout shall be removed and properly disposed of off site. The concrete washout shall remain in place until all concrete for the project is placed.

Any dewatering required for construction shall be pumped to a straw bale/sediment fence pit for filtering, see standard drawing "ESC-41 straw bale/sediment fence pit" detail in Appendix D. Once the wet storage area becomes filled to half of the excavated depth, accumulated sediment shall be removed and properly disposed of.

5.0 Potential Storm Water Pollutant Sources and Control Measures

Pollutants from various sources have the potential to enter the storm water system during project construction. A description of these potential pollutants and control measures to reduce the risk of storm water contamination is provided below.

5.1 Construction Silt and Dust

The pre-developed site is collected by a drainage system on site and flows above ground and through a pipe system to the northeast into un-named tributaries, 0.52 miles from Grindstone Creek. Construction of the project will generate silt and fugitive dust.

Silt barriers (fences/dikes) will be installed along perpendicular to the storm runoff on all disturbed slopes as shown on the Erosion Control Plan to control offsite discharges of silt. The silt barrier will be installed after the clearing and grubbing necessary for placement of the silt barrier is complete, but before the clearing and grubbing of the remaining work area is started. The silt barrier will remain in place until the up slope surface is permanently stabilized. If construction in a particular area will cease temporarily, temporary soil stabilization will be implemented no more than 7 days after the construction has ceased unless activity will resume in that area within 21 days. Permanent stabilization will take place no later than 7 days after construction activities have permanently ceased in an area.

Fugitive dust may be generated during dry weather conditions. Dust control will be directed by the construction manager. Water sprays will be used for dust control.

5.2 Offsite Sediment Tracking

Contractor is responsible for keeping all public roadways adjacent to the construction site free of dirt and debris resulting from activities related to the construction of this project. The site access drive will be aggregate construction and maintained to reduce tracking of sediment offsite.

5.3 Petroleum Products

Construction equipment will require diesel fuel and oil on a regular basis, so the potential exists for spills or leaks. All onsite vehicles will be monitored for leaks and receive regular preventative maintenance to ensure proper operation and reduce the chance of leaks. No "*topping off*" of fuel tanks will be allowed to reduce the possibility of spills.

Petroleum products will be stored in clearly labeled and tightly sealed containers or tanks. Any asphalt used onsite will be applied according to the manufacturer's recommendations. Any soil Contaminated by fuel or oil spills will be removed and disposed of at an approved disposal site by MU Environmental Health & Safety. The contractor shall not remove or dispose contaminated soils.

5.4 Sanitary Wastes

A licensed sanitary waste management contractor will collect all construction or temporary sanitary wastes from portable units. The units will be maintained on a regular basis.

5.5 Hazardous Wastes

MU Environmental Health & Safety will remove and dispose of any hazardous waste according to local or state regulation or the manufacturer's recommendations. The contractor shall not remove or dispose any hazardous waste materials. The Construction Manager who will also be responsible for their implementation will instruct site personnel of these regulations and recommendations.

5.6 Fertilizers

Fertilizers will be applied as recommended by the manufacturer. After application the fertilizer will be worked into the soil to limit exposure to storm waters. Fertilizers will be stored in a covered area or in watertight containers. Any partially used bags or containers will be properly sealed and stored to avoid spills or leaks.

5.7 Paints

All paint containers will be tightly sealed and properly stored to prevent leaks or spills. Paint will not be discharged to the storm water system. MU Environmental & Health Safety will remove and dispose of any unused paints according to local and/or state regulations. The contractor shall not remove or dispose any unused paints. Spray painting will not occur on windy days and a drop cloth will be used to collect and dispose of drips and over-spray associated with all painting activities.

5.8 Concrete Trucks

Concrete trucks will be allowed to discharge surplus concrete or drum wash water on the site in such a manner that prevents contact with storm waters discharging from the site. Dikes or barriers will be constructed around such an area to contain these materials until stable, at which time the materials will be disposed of in a manner acceptable to the Construction Manager and the construction site inspector.

5.9 Waste Materials

All construction waste material will be collected, deposited and stored in metal dumpsters from a licensed solid waste management contractor. No construction waste materials will be buried onsite. Burning of waste construction materials on site is not allowed. For burning allowances, see the MU Burn Permit in Appendix A. The MU Burn Permit must be filled out and submitted to MU-EHS for approval prior to any burning on site. All site personnel will be instructed of the proper waste disposal procedures by the Construction Manager.

5.10 Allowable Non-Storm Water Discharges

The following sources of non-storm water discharges from project construction activities may be combined with storm water discharges.

- Washing vehicles is only allowed if no cleaning agents are used. Sediment must settle before reaching the storm drain.
- Waters used to control dust
- Pavement wash waters not containing toxic or hazardous substances
- Uncontaminated dewatering discharges
- Fire fighting waters
- Vegetation watering
- Potable or spring water discharges

6.0 Best Management Practices

Chemicals, petroleum products and other materials will be used and stored on the project site. Best Management Practices, such as good housekeeping measures, inspections, containment, and spill prevention practices will be used to limit contact between storm water and potential pollutants.

6.1 Good Housekeeping

The good housekeeping practices listed below will be followed to reduce the risk of potential pollutants entering storm water discharges. All construction personnel will be responsible for monitoring and maintaining housekeeping tasks or notifying the appropriate person of a problem.

- Store only enough products to do the job.
- Store all materials in a neat and orderly manner, in the appropriate containers and, if possible, under a roof or within an enclosure
- Keep products in the original container with original manufactures label.
- Do not mix products unless recommended by the manufacturer
- Use all of a product before disposing of the container.

- Use and dispose of products according to the manufacture's recommendations or the Construction Manager's direction.
- Perform regular inspections of the storm water system and the material storage areas.
- When and where appropriate, use posters, bulletin boards, meetings, etc. to remind and inform construction personnel of required procedures.

6.2 Hazardous Materials

Storage areas for hazardous materials such as oils, greases, paints, fuels, and chemicals must be provided with secondary containment to ensure that spills in these areas do not reach waters of the State. MU-EHS must be contacted in the event any soil becomes contaminated. MU-EHS will dispose of any contaminated soil. The contractor shall not dispose of any contaminated soil without consulting MU-EHS.

6.3 Spill Prevention and Response

In addition to the good housekeeping and hazardous materials storage procedures described above, spill prevention and cleanup practices will be as follows.

- Construction personnel will be informed of the manufacturer's recommended spill cleanup methods and the location of that information and clean up supplies.
- Materials and equipment for the cleanup of a relatively small spill will be kept in the materials storage area. These facilities may include brooms, rags, gloves, shovels, goggles, sand, sawdust, plastic or metal trash containers, and protective clothing.
- All containers will be labeled, tightly sealed, and stacked or stored neatly and securely.

The spill response procedure will be as follows:
Step 1. Upon discovery of a spill, stop the source of the spill.
Step 2. Cease all spill material transfer until the release is stopped and waste removed from the spill site.
Step 3. Initiate containment to prevent spill from reaching State waters.
Step 4. Notify a Supervisor or the Construction Manager of the spill.
Step 5. The Construction Manager will coordinate further cleanup activities
Step 6. In case of significant spill of hazardous material, the Construction Manager should call 911 in case of immediate danger to life or health and MU EHS, but MU EHS will decide if a reportable spill has occurred and will make the appropriate notifications to other agencies as necessary.
Step 7. Review the construction storm water pollution prevention plan and amend if needed. Step 8. Record a description of the spill, cause, and cleanup measures taken.

7.0 Inspection, Maintenance, and Reporting Procedures

Site inspection and facility maintenance are important features of an effective storm water management system. Qualified personnel will inspect disturbed areas of the site not finally stabilized, storage areas exposed to precipitation, all control measures, and site access areas to determine if the control measures and storm water management system are effective in preventing significant impacts to receiving waters.

7.1 Erosion and Sediment Controls

The following procedures will be used to maintain erosion and sedimentation controls.

- The contractor in conjunction with the MU inspector shall perform inspections of erosion and sediment control measures at least once per seven calendar days. If a rainfall causes stormwater runoff to occur onsite, the BMPs must be inspected. These inspections must occur within 48 hours after the rain event has ceased during a normal work day and within 72 hours on the next business day if the rain event ceases during a non-work day such as a weekend or holiday.
- The contractor is responsible for providing erosion and sediment control BMPs to prevent sediment from reaching paved areas, storm sewer systems, drainage courses and adjacent properties. In the event the prevention measures are not effective, the contractor shall remove any debris, silt or mud and restore the right of way, or adjacent properties to original or better condition.
- The contractor shall seed, mulch or otherwise stabilize where soil disturbing activities will cease on any portion of the site and are not planned to resume for a period exceeding 14 calendar days. Temporary stabilization must be initiated immediately upon knowing the duration is more than 14 days. Temporary stabilization must be completed within 7 calendar days.
- The contractor is responsible for providing erosion and sediment control for the duration of the project.
- Temporary and permanent seeding and planting will be inspected for bare spots, washouts and healthy growth.
- Inspect riprap and aggregate covered areas for bare spots and washouts.
- The Construction Manager will select individuals to be responsible for inspections, maintenance, repairs, and reporting. The designated individuals will receive necessary training from the Construction Manager to properly inspect and maintain the controls in good working order.
- Inspection Form 1 will be completed after each inspection.

7.2 Non-Storm Water Controls

The following procedures will be used to maintain the non-storm water controls.

All control measures will be inspected at least once a week and after each runoff producing rainfall event and daily during prolonged rainfall periods.

All control measures will be maintained in good working order. If a repair is necessary, it will be initiated and repaired within 24 hours of the inspection.

The Construction Manager will select individuals to be responsible for inspections, maintenance, repairs, and reporting. The designated individuals will receive the necessary training from the Construction Manager to properly inspect and maintain the controls in good working order.

Inspection Form 2 will be completed after each inspection.

The completed Inspection Forms will be kept with this Plan in Appendix B.

7.3 Reporting

Two inspection forms are provided on the following pages for recording inspections and maintenance of the control measures: Erosion and Sedimentation Controls (Inspection Form 1), and Non-Storm Water Source Controls (Inspection Form 2). All disturbed areas and materials storage areas require inspection at least once per seven calendar days. If a rainfall causes stormwater runoff to occur onsite, the BMPs must be inspected. Theses inspections must occur within 24 hours after the rain event has ceased during a normal work day and within 48 hours on the next business day if the rain event ceases during a no-work day such as a weekend or holiday. After each inspection, the inspector completes an inspection report and inserts that report in Appendix B of this Plan. Any required maintenance is initiated within 24 hours of the inspection.

A fully signed copy of this Plan and any support materials must be maintained at the project site from the date of the project initiation to the date of final stabilization. All records and supporting documents will be complied in an orderly manner and maintained for a period of three years following final stabilization.

The generation of reports, as part of the construction process and inspection or amendment procedures, provides accurate records that can be used to evaluate the effectiveness of this Plan and document the plans compliance. Changes in design or construction of the storm water management system are documented and included with the Plan to facilitate Plan review or evaluation. Four forms have been developed to assist the Construction Manager with record keeping activities.

- Record of Plan Amendments
- Construction Activity Record
- Erosion and Sedimentation Controls Inspection Form 1
- Non-Storm Water Source Controls Inspection Form 2

Plan amendments will be documented on the form in the front of this Plan and on the drawings. A record of construction activities will be maintained in Appendix A of this Plan. Completed inspection and maintenance forms will be kept in Appendix B of this Plan.

Inspection Form 1

Erosion and Sedimentation Controls

Visually inspect disturbed areas of the construction site that have not been finally stabilized. Inspections to be completed every 7 days and within 24 hours of a rainfall event of ½ inch or more. Maintenance to be preformed within 24 hours of inspection.

Inspector: _____

Inspection Date: _____

Date of last rainfall: _____

Amount of last rainfall: _____inches

Report on the condition of the erosion and sedimentation controls installed at the construction site. Check for tears in silt barriers, for securely attached fabric to fence posts, and for depth of sediment in front of the silt barriers. The depth of sediment should not exceed one-half of the barrier height. Seeding/planting areas and rip-rap aggregate areas should be inspected for bare spots and washouts.

Area	Condition of Control	Maintenance Required/Completion Date

Inspection Form 2

Non-Storm Water Source Controls

Visually inspect material storage and construction areas. Inspections to be completed every 7 days and within 24 hours of a rainfall event of ½ inch or more. Maintenance to be performed within 24 hours of inspection.

Inspector: _____

Inspection Date: _____

Date of last rainfall: _____

Amount of last rainfall: _____inches

Construction Dust- Is there excessive dust at the site that requires watering?

_____

_____

Sediment Tracking – Is Street mostly free from mud, dirt, or rock?

Is wash down required? _____

Are graveled areas adequately covered? _____

Petroleum/Chemical Products – Are spill containment structures secure? Product containers securely sealed? _____

Sanitary Waste – Do portable sanitary units need service? _____

Hazardous waste – Are hazardous wastes stored and disposed of in compliance with state and local regulations? _____

Inspection Form 2
Non-Storm Water Source Controls
(Continued)

Construction Waste – Are all construction waste materials collected and stored in approved dumpsters? _____

Material Storage Areas Exposed to precipitation – Are materials handled and stored in a manner to prevent leakage and prevent pollutants from entering the storm water system? _____

Other Non-Storm Water Discharges – Are waters from line flushing, pavement wash down, and dewatering directed to the storm water system prior to discharge? _____

Maintenance Required	Maintenance Completed Date

8.0 Certification of Compliance

This Construction Storm Water Pollution Prevention Plan reflects best management practices and erosion and sedimentation control measures for storm water management as practices and erosion and sedimentation control measures for storm water management as recommended by the Environmental Protection Agency.

8.1 Contractor Certifications

The Contractor Certification forms provided in this section indicate that each contractor or subcontractor working on the project site understands the terms, conditions, and intent of the NPDES General Permit for Construction Storm Water Discharges Associated with Construction Activity and will implement the measures described in this Plan appropriate to his area of work.

If additional sheets are needed due to more subcontractors on site than sheets provided herein, additional sheets may be copied and inserted into booklet at the job site.

9.0 Project Completion

Construction is considered complete when the project is 70% of fully established plant density over 100% of the disturbed area. The Construction Manager may terminate construction erosion and sediment control measures at this time. MU Construction Management will submit a Request for Closure to MU EHS to make the final determination to close the site disturbance permit.

Permanent storm water control measures incorporated into the project site design include vegetated swales, aggregate surfacing of facility areas, culvert inlet/outlet protection and a storm water retention basin.

10.0 References

The references used to develop this plan and provide further details on items mentioned in this plan are as follows:

1) *Storm Water Management for Construction Activities- Developing Pollution Prevention Plans And Best Management Practices* (EPA 832-R-92-005, September 1992)

2) *Protecting Water Quality: A field guide to erosion, sediment and storm water best management practices for development sites in Missouri***,** published by the Missouri Department of Natural Resources. This manual is available on the department's internet site at: http://www.dnr.mo.gov.env/wpp/wpcp-guide.htm.

3) SECTION 015713 – TEMPORARY EROSION AND SEDIMENT CONTROL AND SWPPP. Available in the set of specifications in the project package.

4) Drawing Sheet C0.51, Erosion Control Plan and C0.52, Erosion Control Details. Available in the drawing set in the project package.

5) Drawing Sheet C3.01, SITE GRADING PLAN. Available in the drawing set in the project package.

Appendix A

Location Map
USGS Map

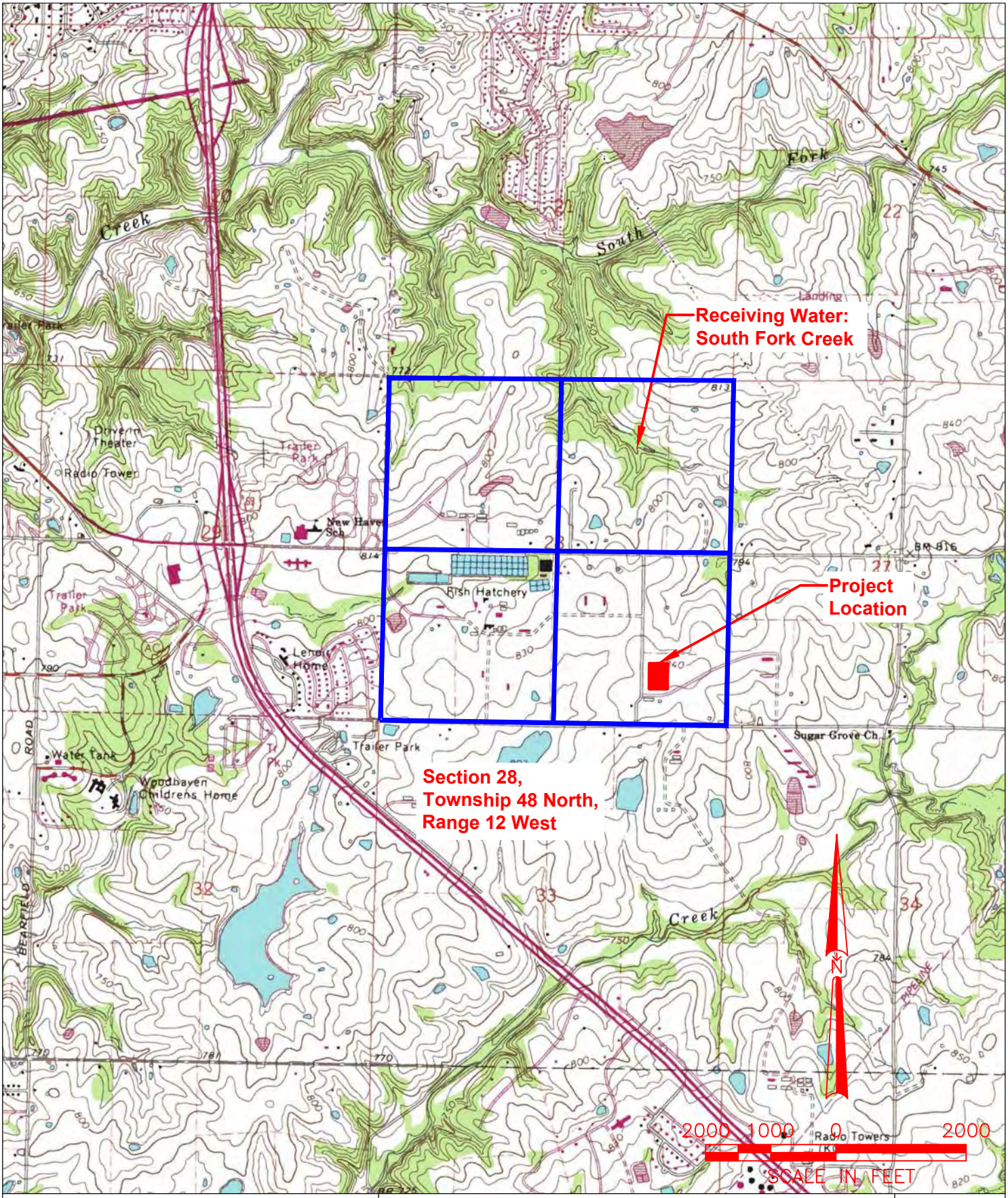
SK Design Group, Inc.
4600 College Boulevard,
Suite 100
Overland Park, Kansas 66211
Tel: 913-451-1818
Fax: 913-451-7599

LOCATION MAP

CP201372
University of Missouri Swine Research Facility
South Farm Columbia, MO 6520

Appendix A
EXHIBIT
1

February 2021



SK Design Group, Inc.
4600 College Boulevard,
Suite 100
Overland Park, Kansas 66211
Tel: 913-451-1818
Fax: 913-451-7599

USGS MAP

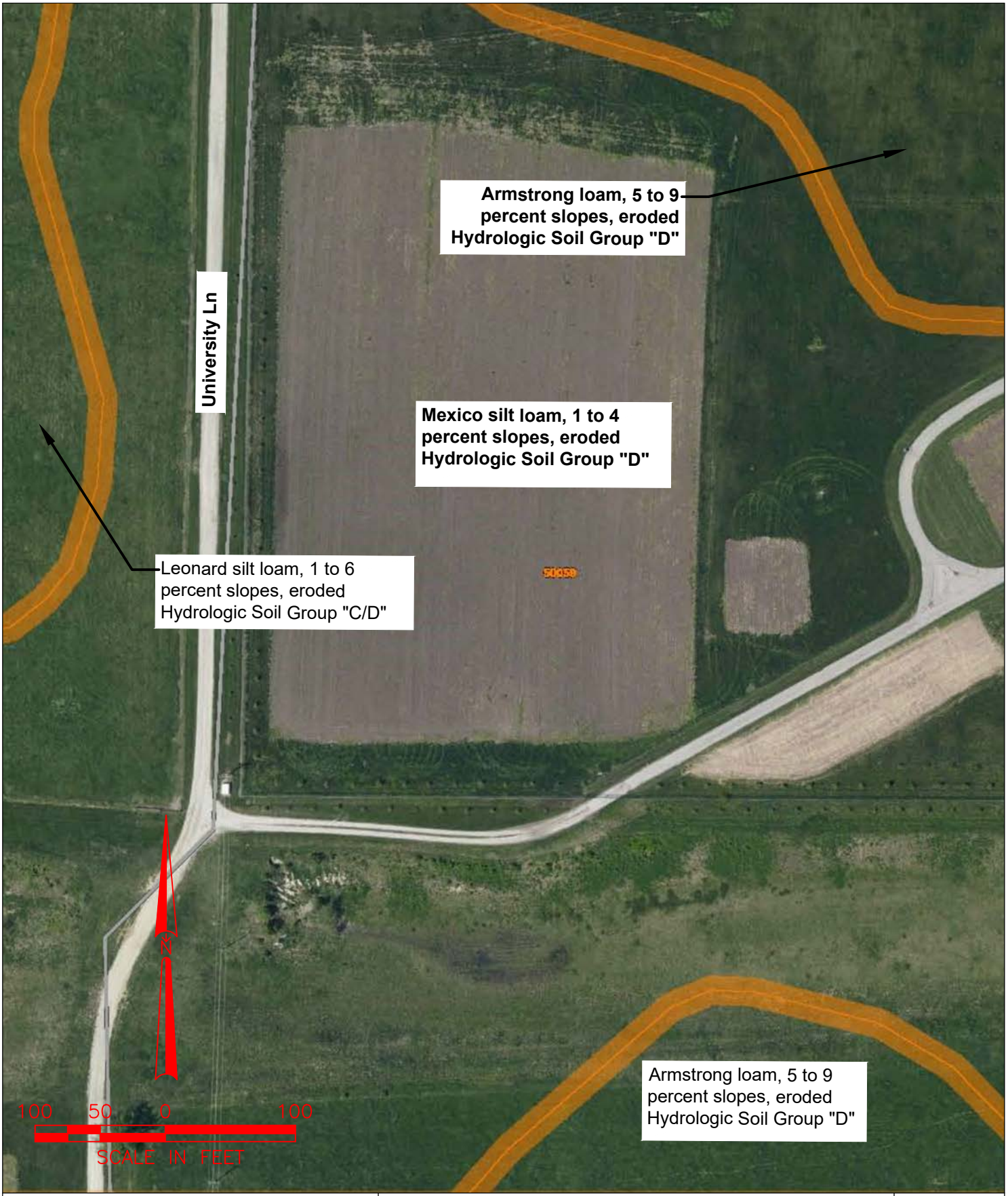
CP201372
University of Missouri Swine Research Facility
South Farm Columbia, MO 65201

Appendix A
EXHIBIT
2

February 2021

Appendix B

USDA Soil Report



SK Design Group, Inc.
4600 College Boulevard,
Suite 100
Overland Park, Kansas 66211
Tel: 913-451-1818
Fax: 913-451-7599

SOIL MAP

CP201372
University of Missouri Swine Research Facility
South Farm Columbia, MO 65201

Appendix A
EXHIBIT
3

February 2021

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Boone County, Missouri

February 2, 2021

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....5
Soil Map.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....11
Map Unit Descriptions.....11
Boone County, Missouri.....13
50001—Armstrong loam, 5 to 9 percent slopes, eroded.....13
50059—Mexico silt loam, 1 to 4 percent slopes, eroded.....14
60022—Leonard silt loam, 1 to 6 percent slopes, eroded.....16
References.....18

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Map Scale: 1:1,610 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Boone County, Missouri
Survey Area Data: Version 26, May 29, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
50001	Armstrong loam, 5 to 9 percent slopes, eroded	1.9	13.9%
50059	Mexico silt loam, 1 to 4 percent slopes, eroded	11.7	86.1%
60022	Leonard silt loam, 1 to 6 percent slopes, eroded	0.0	0.0%
Totals for Area of Interest		**13.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Boone County, Missouri

50001—Armstrong loam, 5 to 9 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2x425
Elevation: 560 to 920 feet
Mean annual precipitation: 37 to 45 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 175 to 195 days
Farmland classification: Not prime farmland

Map Unit Composition

Armstrong and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Armstrong

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess over red palesol and underlying subglacial till

Typical profile

Ap - 0 to 8 inches: loam
BE - 8 to 11 inches: loam
Bt1 - 11 to 14 inches: clay loam
2Bt2 - 14 to 18 inches: clay loam
2Bt3 - 18 to 26 inches: clay
2Bt4 - 26 to 54 inches: clay loam
2C - 54 to 79 inches: clay loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.01 in/hr)
Depth to water table: About 12 to 16 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: R109XY046MO - Till Upland Savanna
Hydric soil rating: No

Minor Components

Leonard

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R113XY002MO - Loess Upland Prairie
Hydric soil rating: Yes

Lindley

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: F109XY009MO - Till Protected Backslope Forest, F109XY022MO - Till Exposed Backslope Woodland
Hydric soil rating: No

Keswick

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: F109XY007MO - Till Upland Woodland
Hydric soil rating: No

50059—Mexico silt loam, 1 to 4 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2wvc5
Elevation: 570 to 920 feet
Mean annual precipitation: 37 to 41 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 189 to 212 days
Farmland classification: Not prime farmland

Map Unit Composition

Mexico and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mexico

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loess over pedisediment

Typical profile

Ap - 0 to 7 inches: silt loam
Btg1 - 7 to 15 inches: silt loam
Btg2 - 15 to 34 inches: clay
Btg3 - 34 to 42 inches: silty clay loam
2Btg4 - 42 to 79 inches: silty clay loam

Properties and qualities

Slope: 1 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: R113XY001MO - Claypan Summit Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: Yes

Minor Components

Armstrong

Percent of map unit: 7 percent
Landform: Interfluves
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY006MO - Till Upland Prairie
Hydric soil rating: No

Putnam

Percent of map unit: 5 percent
Landform: Divides
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear

Ecological site: R113XY001MO - Claypan Summit Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: Yes

Leonard

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R113XY002MO - Loess Upland Prairie
Hydric soil rating: Yes

60022—Leonard silt loam, 1 to 6 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2x41x
Elevation: 570 to 980 feet
Mean annual precipitation: 35 to 43 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 190 to 210 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Leonard and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Leonard

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Loess over till

Typical profile

Ap - 0 to 8 inches: silt loam
2Btg1 - 8 to 26 inches: silty clay
2Btg2 - 26 to 79 inches: silty clay loam

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 6 to 18 inches

Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water capacity: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Ecological site: R113XY002MO - Loess Upland Prairie
Hydric soil rating: Yes

Minor Components

Armstrong

Percent of map unit: 7 percent
Landform: Interfluves
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY006MO - Till Upland Prairie
Hydric soil rating: No

Mexico

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R113XY001MO - Claypan Summit Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: Yes

Keswick

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: F109XY007MO - Till Upland Woodland
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

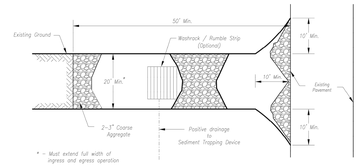
United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

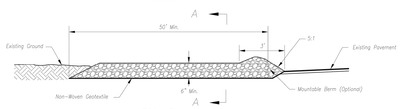
United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Appendix C

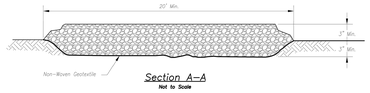
SWPPP Details



Plan View
Not to Scale



Side Elevation
Not to Scale



Section A–A
Not to Scale

Notes for Construction Entrance:

1. Avoid locating on steep slopes, at curves on public roads, or downhill of disturbed area.
2. Remove all vegetation and other unsuitable material from the foundation area, grade, and crown for positive drainage.
3. If slope towards the public road exceeds 2%, construct a 6– to 8–inch high ridge with 3H:1V side slopes across the foundation approximately 15 feet from the edge of the public road to divert runoff from it.
4. Install pipe under the entrance if needed to maintain drainage ditches along public roads.
5. Place stone to dimensions and grade as shown on plans. Leave surface sloped for drainage.
6. Divert all surface runoff and drainage from the entrance to a sediment control device.
7. If conditions warrant, place geotextile fabric on the graded foundation to improve stability.

Maintenance for Construction Entrance:

1. Reshape entrance as needed to maintain function and integrity of installation. Top dress with clean aggregate as needed.

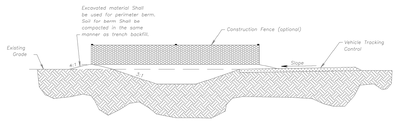
CONSTRUCTION ENTRANCE

Notes for Concrete Washout:

1. Concrete washout areas shall be installed prior to any concrete placement on site.
2. Concrete washout area shall include a flat subsurface pit sized appropriately for the concrete truck and pump truck chutes. The slopes leading out of the subsurface pit shall be 3:1. The vehicle tracking pad shall be sloped towards the concrete washout area.
3. Vehicle tracking control is required at the access point to all concrete washout areas.
4. Signs shall be placed at the construction site entrance, washout area and elsewhere as necessary to clearly indicate the location(s) of the concrete washout area(s) to operators of concrete truck and pump rigs.
5. A one–piece impervious liner may be required along the bottom and sides of the subsurface pit in sandy or gravelly soils.

Maintenance for Concrete Washout:

1. Concrete washout materials shall be removed once the materials have filled the washout to approximately 75% full.
2. Concrete washout areas shall be enlarged as necessary to maintain capacity for wasted concrete.
3. Concrete washout water, wasted pieces of concrete and all other debris in the subsurface pit shall be transported from the job site in a water–tight container and disposed of properly.
4. Concrete washout areas shall remain in place until all concrete for the project is placed.
5. When concrete washout areas are removed, excavations shall be filled with suitable compacted backfill and topsoil, any disturbed areas associated with the installation, maintenance, and/or removal of the concrete washout areas shall be stabilized.

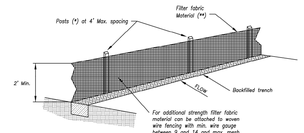


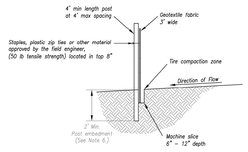
CONCRETE WASHOUT

Construction Entrance modified from 2015 Overland Park Standard Details for Erosion and Sediment Control, Concrete Washout modified from 2009 City of Great Bend Standard Drawings.

AMERICAN PUBLIC WORKS ASSOCIATION	
Kansas City Metro Chapter APWA American Public Works Association	KANSAS CITY METRO CHAPTER
CONSTRUCTION ENTRANCE AND CONCRETE WASHOUT	STANDARD DRAWING NUMBER ESC-01 ADOPTED: 10/24/2016

1 CONCRETE ENTRANCE & CONCRETE WASHOUT
Not to Scale





(*) POSTS
- MIN. LENGTH 4'
- HARDWOOD 1 ¾" x 1 ¾"
- NO.2 SOUTHERN PINE 2 ¾" x 2 ¾"
- STEEL 1.33 LB/FT

(**) – Geotextile Fabric shall meet the requirements of AASHTO M288

Notes:

1. In order to contain water, the ends of the silt fence must be turned uphill (Figure A).
2. Long perimeter runs of silt fence must be limited to 100'. Runs should be broken up into several smaller segments to minimize water concentrations (Figure A).
3. Long slopes should be broken up with intermediate rows of silt fence to slow runoff velocities.
4. Attach fabric to upstream side of post.
5. Install posts a minimum of 2' into the ground.
6. Trenching will only be allowed for small or difficult installation, where slicing machine cannot be reasonably used.

SILT FENCE DETAILS
Not to Scale

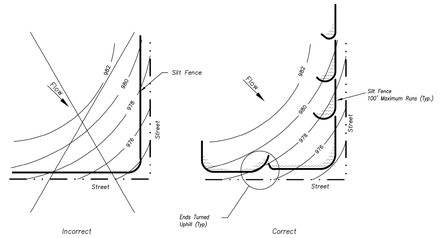
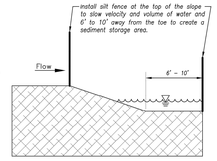
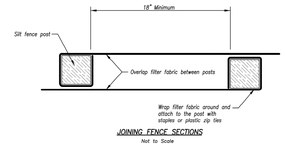


Figure A

SILT FENCE LAYOUT
Not to Scale





JOINING FENCE SECTIONS
Not to Scale

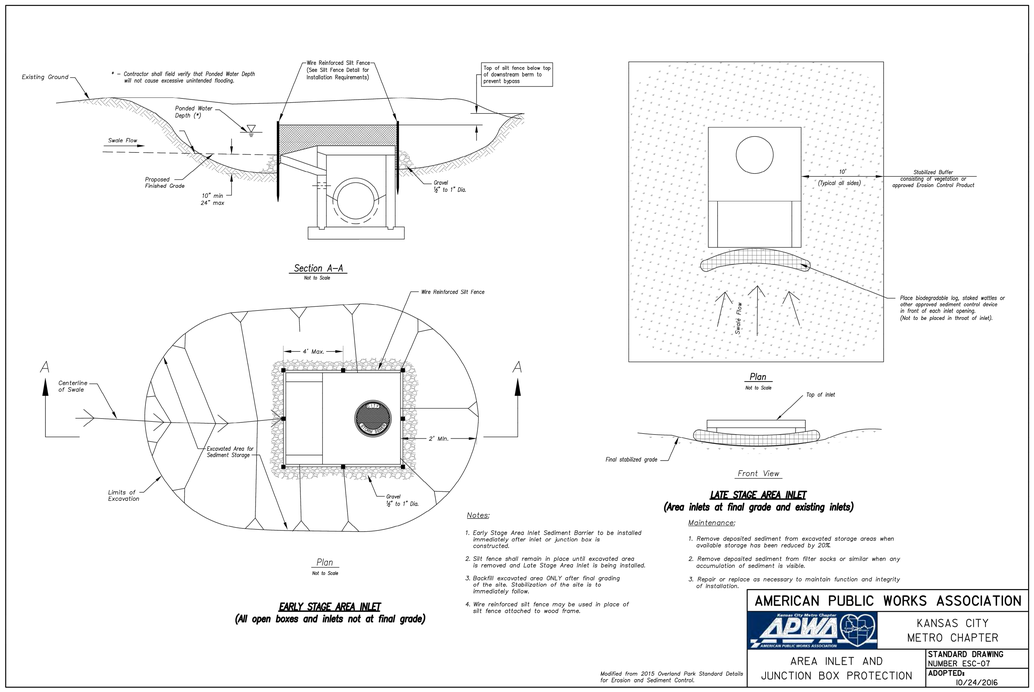
Notes:

1. Remove and dispose of sediment deposits when the deposit approaches ½ the height of silt fence.
2. Repair as necessary to maintain function and structure.

Modified from 2015 Overland Park Standard Details for Erosion and Sediment Control.

AMERICAN PUBLIC WORKS ASSOCIATION	
Kansas City Metro Chapter APWA American Public Works Association	KANSAS CITY METRO CHAPTER
SILT FENCE	STANDARD DRAWING NUMBER ESC-03 ADOPTED: 10/24/2016

2 SILT FENCE
Not to Scale



EARLY STAGE AREA INLET
(All open boxes and inlets not at final grade)

Notes:

1. Early Stage Area Inlet Sediment Barrier to be installed immediately after inlet or junction box is constructed.
2. Silt fence shall remain in place until excavated area is removed and Late Stage Area Inlet is being installed.
3. Backfill excavated area ONLY after final grading of the site. Stabilization of the site is to immediately follow.
4. Wire reinforced silt fence may be used in place of silt fence attached to wood frame.

LATE STAGE AREA INLET
(Area inlets at final grade and existing inlets)

Maintenance:

1. Remove deposited sediment from excavated storage areas when available storage has been reduced by 20%.
2. Remove deposited sediment from filter socks or similar when any accumulation of sediment is visible.
3. Repair or replace as necessary to maintain function and integrity of installation.

Modified from 2015 Overland Park Standard Details for Erosion and Sediment Control.

AMERICAN PUBLIC WORKS ASSOCIATION	
Kansas City Metro Chapter APWA American Public Works Association	KANSAS CITY METRO CHAPTER
AREA INLET AND JUNCTION BOX PROTECTION	STANDARD DRAWING NUMBER ESC-07 ADOPTED: 10/24/2016

3 AREA INLET & JUNCTION BOX PROTECTION
Not to Scale

CLARK & ENERSEN

Architecture \ Engineering \ Interior Design \ Landscape Architecture \ Planning

clarkenersen.com

Kansas City, Missouri
2020 Baltimore Ave., Suite 300
Kansas City, MO 64108-1914
816.474.8237

Lincoln, Nebraska
Fairway, Kansas
Fort Collins, Colorado

SK Design Group, Inc.
Civil Engineers
4600 College Blvd., Suite 100
Overland Park, KS 66211
(913)-451-1818
fax (913)-451-7599
www.skdg.com

SHEET HISTORY:

ISSUED 02/08/2021 CONTRACT DOCUMENTS

Contract Documents

University of Missouri South Farm - Swine Research Facility

South Farm
Columbia, MO 65201

CE No.: 624-187-20
MU No.: CP201372

February 8, 2021

STATE OF MISSOURI
SASSAN MAJDIAN
NUMBER E-20961
REGISTERED PROFESSIONAL ENGINEER

Construction Set
Issued: 05/20/2021

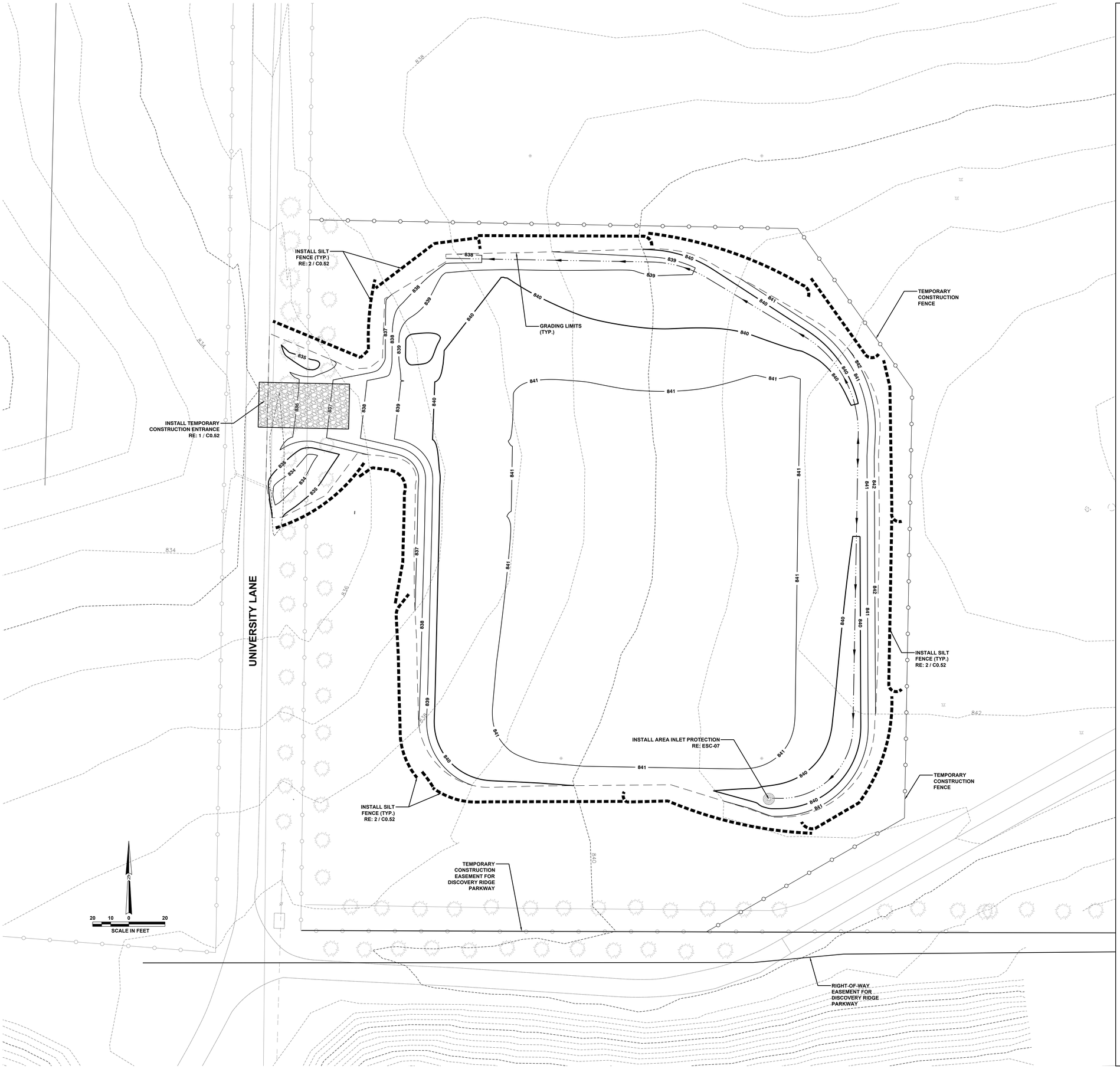
Site Erosion Control Details

C0.52

Plot Time Stamp: 5 / 20 / 2021 11:25:21 AM
File Location/Name: U:\2020\20-124\2021-05-20 For Construction\C052-20124 Erosion Details.dwg

Appendix D

SWPPP Site Plan



Plot Time Stamp: 5 / 20 / 2021 11:24:17 AM
File Location/Name: U:\2020\20-126\2021-05-20 For Construction\C051-20126 Erosion Plan.dwg

EROSION CONTROL NOTES

1. EXCEPT WHERE NECESSARY TO INSTALL EROSION AND SEDIMENT CONTROL DEVICES, CLEARING & DEMOLITION ACTIVITIES SHALL NOT BEGIN UNTIL ALL EROSION CONTROL DEVICES AND CONSTRUCTION FENCING HAVE BEEN INSTALLED AND APPROVED BY THE OWNER'S REPRESENTATIVE.
2. THE CONTRACTOR SHALL PROVIDE FOR CONTROL OF SURFACE EROSION AND SEDIMENT DEPOSITION DURING ALL PHASES OF CONSTRUCTION AND UNTIL THE OWNER ACCEPTS THE WORK AS COMPLETE. THE CONTRACTOR SHALL PROVIDE TEMPORARY SEEDING, BERMS, SILT FENCE, SEDIMENT TRAPS, OR OTHER MEANS TO PREVENT SEDIMENT FROM REACHING THE PUBLIC RIGHT-OF-WAY, STREAMS OR ADJACENT FACILITIES. IN THE EVENT THE PREVENTION MEASURES ARE NOT EFFECTIVE, THE CONTRACTOR SHALL REMOVE ANY DEBRIS SEDIMENT AND RESTORE THE PROPERTY TO IT'S ORIGINAL OR BETTER CONDITION.
3. CONTRACTOR IS RESPONSIBLE FOR KEEPING ALL ROADWAYS & SIDEWALKS ADJACENT TO THE CONSTRUCTION SITE FREE OF DIRT AND DEBRIS RESULTING FROM ACTIVITIES RELATED TO THE CONSTRUCTION OF THIS PROJECT.
4. THE CONTRACTOR SHALL CLEAN THE STREET ONCE PER DAY MINIMUM WHEN HEAVY TRACKOUT OCCURS. CONTRACTOR SHALL PROVIDE ADDITIONAL STREET CLEANING AT HIS OWN EXPENSE TO KEEP STREETS CLEAN FROM MUD AND DEBRIS AS NECESSARY.
5. CONTRACTOR SHALL KEEP THE ENTIRE PROJECT SITE FREE OF DEBRIS AND TRASH AT ALL TIMES. CONTRACTOR SHALL EXECUTE WORK USING METHODS THAT MINIMIZE EXCESSIVE NOISE OR DUST EMISSIONS. CONTRACTOR SHALL PROVIDE METHODS, MEANS AND FACILITIES TO PREVENT CONTAMINATION OF SOIL OR WATER FROM DISCHARGE OF REGULATED MATERIALS (I.E., DIESEL FUEL) USED DURING CONSTRUCTION. CONTRACTOR SHALL PROVIDE SECONDARY CONTAINMENT WHEN MORE THAN 50 GALLONS OF FUEL ARE STORED ON SITE.
6. STOCKPILE AREAS SHALL BE GRADED SUCH THAT THEY DO NOT EXCEED 3:1, SILT FENCE SHALL BE INSTALLED AROUND THE PERIMETER OF THE AREAS AND THE AREAS SHALL BE SEEDED WITHIN 14 DAYS ONCE CONSTRUCTION ACTIVITIES ON THEM CEASE
7. THE CONTRACTOR SHALL REQUEST THE OWNER'S REPRESENTATIVE TO INSPECT AND APPROVE THE SEDIMENT CONTROL MEASURES UPON THE COMPLETION OF VARIOUS STAGES OF THE WORK.
8. CONTRACTOR MUST INSTALL AND MAINTAIN THE EROSION CONTROL MEASURES SHOWN ON THIS PLAN. IF THE ENGINEER, OWNER'S REPRESENTATIVE, DETERMINES THAT THE INSTALLATION OR THE MAINTENANCE IS INADEQUATE, THE CONTRACTOR MUST IMMEDIATELY CORRECT AT THEIR EXPENSE. IF IT IS DETERMINED THAT ADDITIONAL EROSION CONTROL MEASURES ARE NEEDED THE CONTRACTOR WILL BE DIRECTED TO INSTALL AND MAINTAIN THOSE MEASURES
9. FOLLOWING THE FINAL REMOVAL OF ALL EROSION CONTROL MEASURES THE CONTRACTOR SHALL RE-GRADE AND RE-SOD ALL AREAS THAT WERE DISTURBED BY THE REMOVAL.
10. THE CONTRACTOR SHALL INSPECT THE LAND DISTURBANCE SITE AT LEAST ONCE EVERY SEVEN (7) DAYS AND WITHIN TWENTY-FOUR (24) HOURS FOLLOWING EACH RAINFALL EVENT OF 0.25" OR MORE WITHIN ANY TWENTY-FOUR (24) HOUR PERIOD. THE CONTRACTOR SHALL ALSO INSPECT AND ASSURE THAT ALL SEDIMENT CONTROL DEVICES ARE IN WORKING CONDITION PRIOR TO ANY FORECASTED RAINFALL
11. THE CONTRACTOR SHALL REMOVE SEDIMENT FROM THE FLOW AREAS AND MAKE ALL NECESSARY REPAIRS TO MAINTAIN THE INTEGRITY OF THE SEDIMENT CONTROL MEASURES. SEDIMENT SHALL BE REMOVED ONCE IT REACHES 1/2 THE INSTALLED HEIGHT OF MEASURE
12. SOME OF THE EROSION AND SEDIMENT CONTROL MEASURES, WILL REQUIRE THE CONTRACTOR TO INSTALL, REMOVE, AND REINSTALL THE MEASURES AS CONSTRUCTION PROCEEDS. THE PHASING OF THIS WORK IS DEPENDENT ENTIRELY ON THE CONTRACTOR'S SCHEDULE, AND IS NOT SPECIFIED HEREIN. HOWEVER, THE CONTRACTOR SHALL COORDINATE THESE ACTIONS WITH THE ENGINEER AT THE TIMES ADJUSTMENTS ARE NEEDED
13. CONSTRUCTION FENCE SHALL BE APPROVED BY THE OWNER'S REPRESENTATIVE IN THE FIELD. CONTRACTOR SHALL SPRAY PAINT PROPOSED FENCE LOCATION FOR OWNER REVIEW AND APPROVAL PRIOR TO INSTALLATION.
14. CONTRACTOR SHALL BE RESPONSIBLE FOR MOWING ALL AREAS WITHIN CONSTRUCTION FENCING.
15. IMMEDIATE INITIATION OF TEMPORARY STABILIZATION BMPS ON DISTURBED AREAS WHERE CONSTRUCTION ACTIVITIES HAVE TEMPORARILY CEASED ON THAT PORTION OF THE PROJECT SITE IF CONSTRUCTION ACTIVITIES WILL NOT RESUME FOR A PERIOD EXCEEDING 14 CALENDAR DAYS. TEMPORARY STABILIZATION MAY INCLUDE ESTABLISHMENT OF VEGETATION, GEOTEXTILES, MULCHES OR OTHER TECHNIQUES TO REDUCE OR ELIMINATE EROSION UNTIL EITHER FINAL STABILIZATION CAN BE ACHIEVED OR UNTIL FURTHER CONSTRUCTION ACTIVITIES TAKE PLACE TO RE-DISTURB THE AREA. THIS STABILIZATION MUST BE COMPLETED WITHIN 14 CALENDAR DAYS.
16. AN INSPECTION LOG SHALL BE MAINTAINED AND SHALL BE AVAILABLE FOR REVIEW BY THE REGULATORY AUTHORITY.
17. CONCRETE WASH OR RINSEWATER FROM CONCRETE MIXING EQUIPMENT, TOOLS AND/OR READY-MIX TRUCKS, TOOLS, ETC. MAY NOT BE DISCHARGED INTO OR BE ALLOWED TO RUN TO ANY EXISTING WATER BODY OR PORTION OF THE STORMWATER SYSTEM. ONE OR MORE LOCATIONS FOR CONCRETE WASH OUT WILL BE DESIGNATED ON SITE, SUCH WAT DISCHARGES DURING CONCRETE WASHOUT WILL BE CONTAINED IN A SMALL AREA WHERE WASTE CONCRETE CAN SOLIDIFY IN PLACE. PROPER SIGNAGE WILL BE INSTALLED TO DIRECT USERS TO THE CONCRETE WASHOUT. CONCRETE WASHOUTS MUST BE INSTALLED PRIOR TO POURING ANY CONCRETE.
18. POLLUTION OF STREAMS, LAKES, WETLANDS, DRAINAGE WAYS OR STORM SEWERS FROM FUEL, OILS, HAZARDOUS CHEMICALS, SEDIMENT, TRASH, DEBRIS, OR OTHER SUBSTANCES RESULTING FROM CONSTRUCTION ACTIVITIES SHALL NOT BE ALLOWED. CONTRACTOR SHALL REPORT ALL SPILLS TO THE UNIVERSITY OF MISSOURI CONSTRUCTION MANAGER.
19. NOTIFICATION TO ALL CONTRACTORS: THE PERMITTEE SHALL BE RESPONSIBLE FOR NOTIFYING EACH CONTRACTOR OR ENTITY (INCLUDING UTILITY CREWS AND CITY EMPLOYEES OR THEIR AGENTS) WHO WILL PERFORM WORK AT THE SITE OF THE EXISTENCE OF THE SWPPP AND WHAT ACTION OR PRECAUTIONS SHALL BE TAKEN WHILE ON-SITE TO MINIMIZE THE POTENTIAL FOR EROSION AND THE POTENTIAL FOR DAMAGING ANY BMP. THE SWPPP SHALL CONTAIN A LIST OF CONTRACTORS OR ENTITIES THAT HAVE BEEN NOTIFIED. THE PERMITTEE IS RESPONSIBLE FOR ANY DAMAGE A SUBCONTRACTOR MAY DO TO ESTABLISHED BMPS AND ANY SUBSEQUENT WATER QUALITY VIOLATION RESULTING FROM DAMAGE.

LEGEND

- SILT FENCE RE: 2 / C0.52
- INLET PROTECTION RE: 3 / C0.52
- 840 EXISTING CONTOUR
- TEMPORARY CONSTRUCTION ENTRANCE RE: 1 / C0.52

DISTURBED AREA = 2.49 ACRES

CLARK & ENERSEN

Architecture \ Engineering \ Interior Design \ Landscape Architecture \ Planning

clarkenersen.com

Kansas City, Missouri
2020 Baltimore Ave., Suite 300
Kansas City, MO 64108-1914
816.474.8237

Lincoln, Nebraska
Fairway, Kansas
Fort Collins, Colorado

SK Design Group, Inc.
Civil Engineers
4600 College Blvd., Suite 100
Overland Park, KS 66211
(913)-451-1818
fax (913)-451-7599
www.skdg.com

SHEET HISTORY:

ISSUED 02/08/2021 CONTRACT DOCUMENTS
ADD 04 04/05/2021 POST BID ADDENDUM 04

Contract Documents

University of Missouri South Farm - Swine Research Facility

South Farm
Columbia, MO 65201

CE No.: 624-187-20
MU No.: CP201372

February 8, 2021

STATE OF MISSOURI · SASSAN MATDJAKI · NUMBER E-24961 · REGISTERED PROFESSIONAL ENGINEER

Construction Set
Issued: 05/20/2021

Site Erosion Control Plan

C0.51

Appendix E

Construction Activity Record

Construction Activity Record

An accurate and up-to-date record of construction activity must be maintained as a part of this plan. Record the information below on an ongoing basis.

- Dates when major soil disturbing activities occur
- Dates when construction activities temporarily cease on a portion of the site
- Dates when construction activities permanently cease on a portion of the site
- Dates when stabilization measures are initiated

Date	Activity

Appendix F
Completed Inspection Forms

SECTION 01 73 29 - CUTTING AND PATCHING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for cutting and patching.

1.3 QUALITY ASSURANCE

A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would reduce the load-carrying capacity or load-deflection ratio.

B. Operational and Safety Limitations: Do not cut and patch operating elements or safety related components in a manner that would result in reducing the capacity to perform as intended.

C. Visual Requirements: Do not cut and patch exposed work in a manner that results in visual evidence of cutting and patching. Remove and replace work cut and patched in a visually satisfactory manner as determined by Architect.

PART 2 PRODUCTS

2.1 MATERIALS

A. Use materials that are identical to existing materials. If identical materials are not available, use materials that match existing adjacent surfaces to the fullest extend possible. Use materials whose installed performance will equal or surpass that of existing materials.

PART 3 EXECUTION

3.1 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

1. Protection: Protect existing construction during cutting and patching.

3.2 PERFORMANCE

A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.

B. Cutting: Cut existing construction using methods least likely to damage elements to be retained or adjoining construction.

C. Patching: Patch with durable seams that are invisible.

1. Restore exposed finishes in a manner that will eliminate evidence of patching and refinishing.
2. Where removal of walls or partitions extends one finished area into another, patch and repair floor and wall surfaces in the new space to provide an even surface of uniform color and appearance. Remove existing floor and wall coverings and replace with new materials as required to achieve uniform color and appearance.

    a. Where patching occurs in a smooth paint surface, extend final paint coat over entire unbroken surface after the patched area has received primer and second coat.

3. Patch, repair or rehabbing existing ceiling as necessary to provide an even plane surface of uniform appearance.

3.3 CLEANING

A. Thoroughly clean areas and spaces where cutting and patching are performed.

END OF SECTION 01 73 29

SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT TRACKING

1. GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents, including General and Supplementary Conditions and Division 01 General Requirements, apply to the work of this Section.

1.2 SUMMARY

A. This Section specifies requirements for the Contractor's implementation of waste management controls and systems for the duration of the Work.

The intent of this Section is to develop and implement a Construction Waste Management Plan (CWMP) in order to quantify material diverted from Solid Waste Disposal Facility or incineration. Quantities must be reported by weight and consistent in units reported and calculation method throughout.

Diversion Methods and Materials Eligible for Reporting:

1. Appropriate materials suitably placed in a Clean Fill Site may be reported
2. Appropriate materials diverted for use as Wood Derived Fuel (WDF) may be reported

Diversion Methods and Materials Ineligible for Reporting:

3. Material disposal by incineration
4. Excavated soil and land-clearing debris
5. Material for use as Alternative Daily Cover (ADC)
6. Hazardous waste; should be disposed of according to relevant regulations

B. Contractor may subcontract work of this Section to a sub-contractor specializing in recycling and salvaging of construction waste.

1.3 DEFINITIONS

A. ALTERNATIVE DAILY COVER (ADC): Material (other than earthen material) that is placed on the surface of the active face of a municipal solid waste landfill at the end of each operating day.

B. AVERAGE RECYCLING RATE: The weighted average for the diversion of materials by the commingled (mixed-stream) recycling facility over time.

C. CLEAN FILL SITE: Re-grading fill site for land reclamation or other beneficial use. Typically requiring permits, regular site maintenance and hours of operation. With material consisting of demolition debris and construction waste from buildings, roads and highway pavement, and other structures. Commonly comprised of brick, ceramics, concrete, and asphalt paving

fragments that are virtually inert and pose neither a pollution threat to ground or surface waters nor a fire hazard. May contain minimal amounts of wood, metal and inert solids.

D. COMMINGLED WASTE: Waste streams that are combined on the project site and hauled away for sorting into recyclable streams. Also known as mixed or single-stream recycling.

E. DEMOLITION AND CONSTRUCTION DEBRIS: Debris, waste and surplus materials, including recyclables, generated as a result of the Contractor's onsite activities while executing the requirements of the contract. Also, commonly includes materials from renovation, demolition, or deconstruction activities.

F. RECYCLE: Recovery of materials, otherwise diverted from the solid waste stream for remanufacturing.

G. SALVAGE: Recovery of useful items repurposing without the need for remanufacturing or reducing to raw materials due to their intrinsic value.

H. SOLID WASTE DISPOSAL FACILITY: A managed landfill, regulated at the Federal, State, and/or Local level.

1.4 INTENT

A. The Owner and Architect have established that this Project shall track the amount of Demolition and Construction debris. The Contractor shall develop and employ processes that ensure that the amount of demolition and construction debris actually generated during the execution of this project due to error, poor planning, breakage, mishandling, contamination or other factors is minimized.

B. Of the construction and demolition debris generated, as much as is economically feasible shall be reused, salvaged, or recycled. Disposal of construction and demolition debris in solid waste disposal facilities shall be minimized to the greatest extent practical.

C. The Contractor shall develop, for the Architect's review, a Construction Waste Management Plan (CWMP) for this Project.

D. Contractor shall be responsible for ensuring that construction and demolition debris, not otherwise salvaged or recycled will be disposed of at appropriately licensed solid waste disposal facilities.

1.5 SUBMITTALS

1.6 Construction Waste Management Plan (CWMP): Within 21 calendar days after receipt of Notice to Proceed, the Contractor shall provide a plan for review and approval by architect and owner. The Construction Waste Management Plan shall be uploaded in the format provided at the end of this section (available for download here: *http://www.cf.missouri.edu/cf/pdc/contractor_information*) and shall at a minimum contain the following:

1. Analysis of the proposed jobsite waste to be generated, including types and estimated quantities.
2. Solid Waste Disposal Facility Options: The name of the facilities landfills where construction and demolition debris not otherwise salvaged or recycled will be disposed of, the applicable landfill tipping disposal fees, and the projected cost of such disposal.
3. Solid Waste Disposal Facility Certification: Contractor's statement of verification that facilities proposed for use are licensed for types of waste to be deposited and have sufficient capacity to receive waste from this project.
4. Recycling Facility Options: Facilities providing commingled or mixed-stream recycling must provide diversion rates either specific to the project, or an average diversion rate that is regulated by the local or state authority. The average recycling rate for the facility must exclude ADC. Measurements must be based on weight (not volume), using scales. Reporting increments shall be no more than annually, and must use consistent time increments throughout calculations.
5. Alternatives: A list of each material proposed to be salvaged or recycled during the course of the Project and the planned reuse strategy or diversion destination of each. Include the following and any additional items proposed:

    a. Cardboard
    b. Clean wood
    c. Beverage containers
    d. Concrete
    e. Slurry wall materials
    f. Bricks and masonry
    g. Asphalt
    h. Metals from framing, banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze
    i. Mechanical and electrical equipment
    j. Building components which can be removed relatively intact from existing construction
    k. Packaging materials
    l. Glass
    m. Scraps from new gypsum wall board
    n. Carpet and pad
    o. Acoustical ceiling panels
    p. Plastics

6. Meetings: A description of the regular meetings to be held to ensure proper execution of the construction waste management plan.
7. Debris Handling Procedures: A description of the means by which any construction waste materials identified above will be protected from contamination, and a description of the means to be employed in recycling the above materials consistent with requirements for acceptance by designated facilities.
8. Transportation: A description of the means of transportation of the debris (whether debris will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site).

B. Waste Management Progress Report: Concurrent with each Application for Payment, submit a written Waste Management Progress Report in the same format as required for Final Report. Submission of this report shall be a pre-requisite to the Owner's approval of the Contractor's application for Payment. Provide statement indicating original estimated total diversion rate, diversion to date, and expected final diversion rate. Include narrative regarding discrepancies or activity since the previous report.

C. Waste Management Final Report: Within five (5) calendar days of Substantial Completion, submit a written Construction Waste Management Final Report summarizing the types and quantities of materials recycled, salvaged and disposed of under the Construction Waste Management Plan. This report shall be in the same format as the monthly reports. Include the name and location of disposal facilities. Quantities must be reported by weight and consistent in units reported and calculation method throughout. Include the following:

1. Material category
2. Generation point
3. Total quantity of waste by category
4. Total quantity of waste reused
5. Total quantity of waste salvaged, both estimated and actual
6. Total quantity of waste recycled, both estimated and actual
7. Total quantity of waste diverted (salvaged and recycled)
8. Total quantity of waste diverted (salvaged and recycled) as a percentage of total waste

D. Other Submittals:

1. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations.
2. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations.
3. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
4. Landfill Disposal Records: Indicate receipt and acceptance of waste by landfills facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
5. Wood Derived Fuel Processing Facility Records: Indicate receipt and acceptance of materials by (WDF) processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
6. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 ON-SITE OPERATIONS

A. Manager: The Contractor shall designate an on-site person responsible for instructing workers and overseeing and documenting results of the Waste Management Plan for the Project.

B. Distribution: The Contractor shall distribute copies of the Waste Management Plan to the Job Site Foreman, each Subcontractor, and the Owner's Representative.

C. Instruction: The Contractor shall provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the Project.

D. Separation Facilities: The Contractor shall lay out and label a specific area to facilitate separation of materials for recycling, salvage, and return. Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination of materials. Location shall be acceptable to the Owner's Representative.

1. Commingling Waste: Commingling waste at the job site may be allowed, provided that the following conditions are met:

    a. Comminglers shall be included in the Construction Waste Management Plan (CWMP)
    b. Additional comminglers must be pre-approved by the Architect via CWMP addenda, prior to tipping on the job site.

E. Hazardous Wastes: Any unforeseen hazardous wastes shall be separated, stored, and disposed of according to local regulations and as directed by the Owner.

SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT PLAN EXAMPLE

Worksheet available for download here: *http://www.cf.missouri.edu/cf/pdc/contractor_information*

Construction Waste Management Report

Recycled, Diverted, and Reused Materials - ACTUAL

Matl. Stream	Date	Diversion Method / Location	Receipt #	Notes (Material)	Source	Units	Cubic Feet	Square Feet	Lineal Feet	Per Unit (lbs)	Weight (lbs)	Total Stream Weight (lbs)
Concrete Rubble												0.00
	mm/dd/yyyy	eg: Clean Fill		eg: Somename Rd.	eg: Demolition						0.00	
											0.00	
Dimensional Lumber and Wood Cut Pieces												0.00
	mm/dd/yyyy	eg: ACME Inc. Compost		eg: misc wood	eg: Demolition						0.00	
											0.00	
Clean Gypsum Wallboard												0.00
	mm/dd/yyyy	eg: ACME Inc. Compost		eg: gyp board	eg: Demolition						0.00	
											0.00	
Doors & Frames												0.00
	mm/dd/yyyy	eg: SomeGroup Donation		eg: wood trim	eg: Demolition						0.00	
											0.00	
Steel												0.00
	mm/dd/yyyy	eg: ACME Inc. Recycling		eg: steel	eg: Demolition						0.00	
											0.00	
Cardboard & Paper												0.00
	mm/dd/yyyy	eg: ACME Inc. Recycling		eg: pkg boxes							0.00	
											0.00	
Scrap Metal												0.00
	mm/dd/yyyy	eg: ACME Inc. Recycling		eg: zinc/steel	eg: Demolition						0.00	
											0.00	
Carpet & Padding												0.00
	mm/dd/yyyy	eg: ACME Carpeting & Flooring		eg: carpet	eg: Demolition						0.00	
											0.00	
Casework												0.00
	mm/dd/yyyy	eg: University Salvage		eg: casework	eg: Demolition						0.00	
											0.00	
Miscellaneous Equipment												0.00
	mm/dd/yyyy	eg: ACME International Inc.		eg: misc	eg: Demolition						0.00	
											0.00	
										ACTUAL Total Waste Diverted	0.00	(lbs)

Landfill Materials Description - ACTUAL

Matl. Stream	Date	Diversion Method / Location	Receipt #	Notes (Material)	Source	Units	Cubic Feet	Square Feet	Lineal Feet	Per Unit (lbs)	Weight (lbs)	Total Stream Weight (lbs)
General Mixed Waste												0.00
	mm/dd/yyyy	eg: ACME International Inc.		eg: misc	eg: Demolition						0.00	
											0.00	
Alternative Daily Cover												0.00
	mm/dd/yyyy	eg: ACME International Inc.		eg: misc	eg: Demolition						0.00	
											0.00	
										ACTUAL Total Waste to Landfill	0.00	(lbs)

Total Construction Waste - ACTUAL	0.00
Percentage of Waste Diverted From Landfill - ACTUAL	0.00%

END OF SECTION 01 74 19

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned.

B. A Commissioning Authority (CxA), appointed by the Owner, will manage the commissioning process.

C. Related Sections include the following:

1. Section 230800, Mechanical Commissioning Requirements, for specific requirements for commissioning HVAC systems.
2. Section 260800, Electrical Commissioning Requirements, for specific requirements for commissioning electrical systems.
3. Division 22, 23, and 26 Sections - Individual Sections stipulate installation, startup, warranty and training requirements for the system or device specified in that Section.

1.2 REFERENCES

A. ASHRAE Guideline 0-2013: The HVAC Commissioning Process.

B. ANSI/NEBB S110-2019 - Whole Building Technical Commissioning of New Construction

1.3 DEFINITIONS

A. Acceptance Phase - The phase of the project when the facility and its systems and equipment are reviewed, tested, and verified. Most of the functional performance testing occurs during this phase of the project. It will generally occur after the Construction Phase is complete including execution of checklists and startup. The Acceptance Phase typically begins with Substantial Completion and ends with Functional Completion.

B. ASHRAE - American Society of Heating, Refrigeration, and Air-Conditioning Engineers

C. Commissioning (Cx) - The process of verifying all building systems are installed and perform interactively according to the design intent; the systems are efficient, cost effective and meet the Owner’s operational needs; and the installation is adequately documented.

D. Commissioning Authority (CxA) - An individual or company who will oversee the commissioning process; stipulate many of the commissioning requirements; and verify that systems and equipment are designed, installed and tested to meet the Owner’s requirements.

E. Commissioning Team - A group of individuals who will collaborate to ensure the facility is fully and completely commissioned. This team will include the Commissioning Authority, the

Owner's representative, the TAB contractor and a commissioning coordinator provided by the Contractor. Generally the installing contractor, subcontractor and manufacturer will also be an integral member of the team for any given system or equipment.

F. Construction Phase – The phase of the project during which the facility is constructed and/or systems and equipment are installed and started. During this phase Contractors complete installation startup forms, submit operation and maintenance (O&M) information, establish trends, etc. The Construction Phase will generally end upon the completed startup and TAB of systems and equipment.

G. Contractor - As used herein is a general reference to the applicable installing party and can therefore refer to the construction manager, general contractor, subcontractors, or vendors.

H. Deficiency - An installation or condition that is not in conformance with the construction documents and/or the design intent.

I. Functional Completion - A milestone that marks the successful completion of the Acceptance Phase. It generally includes the functional performance testing of the systems in the initial season.

J. Functional Performance Testing - The dynamic testing of systems and equipment under various modes of operation and different conditions. Both component performance and environmental objectives will be monitored during this testing.

K. Party - Individual, company or entity involved in the construction and commissioning activities of the project. Refer to the Commissioning Plan for names, roles and responsibilities.

L. Prefunctional Check – The static testing of equipment to establish that the equipment has been installed correctly.

M. Scheduled Outage – A period of time scheduled by the Owner in which the system is out of service or not in use by the occupants.

N. Startup - A process whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the startup checklist, and energizes the device or system, and verifies it is in proper working order.

O. Systems, Subsystems, and Equipment - Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

P. TAB - Testing, Adjusting and Balancing as specified in Section 230593.

Q. Warranty Phase - Includes the early occupancy of the building and continues through the warranty period into the opposite season from when the system was initially tested.

1.4 GENERAL DESCRIPTION

A. Commissioning is a process to assure all building systems are installed and perform interactively according to the design intent; the systems are efficient, cost effective and meet the Owner's operational needs; the installation is adequately documented; and

operating personnel are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance building systems from installation to fully optimized operation.

B. The Commissioning Authority will work with the Contractor to coordinate, oversee, and document the commissioning process during the Construction and Occupancy/Acceptance Phases of this project.

C. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:

1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.

2. Verify and document proper performance of equipment and systems.

3. Verify that O&M documentation left on site is complete.

D. Commissioning does not take away from or reduce the responsibility of the installing contractors to provide a finished and fully functioning product, nor does it replace the contractor's quality assurance and quality control responsibilities. Commissioning is the Owner's QA/QC and is not intended to be the Contractors QA/QC or project completion list.

1.5 COMMISSIONING TEAM

A. Members Appointed by the Construction Manager, Sub Contractors, Architect and Engineer approved by the Owner's Representative: Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including project superintendent, architect and engineering design professionals, and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. Representatives of the facility user and operation and maintenance personnel.

2. Architect and engineering design professionals who are not the Architect/Engineer designers of record.

1.6 COMMISSIONING PROCESS

A. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.

1. Commissioning during construction begins with a scoping meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.

2. Additional meetings will be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.

3. Equipment documentation is submitted to the CxA during normal submittals, including detailed startup procedures.

4. The CxA works with the Contractors in developing startup plans and startup documentation formats, including providing the Contractors with prefunctional checklists to be completed, during the startup process. The CxA will review contractor submitted start-up plans in conjunction with the Owner. This includes review of any temporary system operational plans (if allowed by the Owner).

5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with prefunctional checklists being completed before functional testing.

6. The Contractors, under their own direction, execute and document the forms and checklists included in the startup plans. The CxA documents that the startup was completed according to the approved plans. This may include the CxA witnessing startup of selected equipment.

7. The Commissioning Authority will review the submittal documents and the early operations and maintenance (O&M) material and develop functional testing procedures. The functional testing procedures will be reviewed with the design team and subcontractors as necessary to clarify operation.

8. The functional tests are executed by the Contractors, under the direction of, and documented by the CxA.

9. The CxA reviews equipment performance trend data obtained during the maximum heating and cooling seasons.

10. The CxA reviews the O&M documentation for completeness and accuracy.

11. Deferred testing is conducted, as specified or required.

1.7 CONTRACTOR'S RESPONSIBILITIES

A. Facilitate the coordination of the commissioning work by the CxA, and ensure that commissioning activities are being included in the project schedule.

B. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to CxA for incorporation into the commissioning plan. Update schedule on a weekly basis throughout the construction period.

C. Furnish a copy of all construction documents, addenda, change orders, and approved submittals and shop drawings related to commissioned equipment to the CxA.

D. Where acceptance testing is to be executed by the system/equipment provider, the Contractor, with the CxA's assistance, will develop final acceptance test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Each checklist, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:

1. Name and/or identification of tested item

2. Time and date of test

3. Deficiencies with issue number, if any, generated as the result of test

E. Review commissioning progress and deficiency reports.

F. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.

G. Assist the CxA as necessary in the deferred testing and deficiency corrections required by the specifications.

H. Certificate of Readiness shall be provided and signed by Contractor, sub-contractor(s), and installer(s) for each system certifying that all subsystems, equipment, test and balancing, and associated controls are ready for testing. Completed startup plan checklists shall accompany this certificate.

I. Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:

1. Participate in construction-phase commissioning coordination meetings.
2. Participate in maintenance orientation and observation.
3. Certify that Work is complete and systems are operational according to the Contract Documents, including test and balancing and calibration of instrumentation and controls.
4. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.

J. Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:

1. Participate in construction-phase commissioning coordination meetings.
2. Participate in maintenance orientation and observation.
3. Provide information to the CxA for updating construction-phase commissioning plan.
4. Provide updated Project Record Documents to the CxA on a regular basis.
5. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CM and CxA, as specified in Division 1, Operating Instructions and Service Manual Log.

1.8 CxA'S RESPONSIBILITIES

A. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving of non-conformance or deficiencies, but ultimately that responsibility resides with the CM and the A/E. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents.

B. At the beginning of the construction phase, an initial construction-phase coordination meeting will be held for the purpose of reviewing the commissioning activities and

establishing tentative schedules for operation and maintenance submittals; TAB Work; and Project completion.

C. Commissioning team meetings will be held no less frequently than monthly and as frequently as weekly, depending on the current level of commissioning activities. Meetings shall be held for the purpose of coordination, communication, and conflict resolution; discuss progress of the commissioning processes.

1.9 COMMISSIONING DOCUMENTATION

A. Commissioning Plan: A living document, prepared and maintained by the CxA, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited to the following:

1. Plan for delivery and review of submittals and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes.
2. Identification of systems and equipment to be commissioned.
3. Description of schedules for testing procedures along with identification of parties involved in performing and verifying tests.
4. Identification of items that must be completed before the next operation can proceed.
5. Description of responsibilities of commissioning team members and listing of contact information for each party.
6. Schedule for commissioning activities to be coordinated with overall construction schedule.
7. Process and schedule for completing prestart and startup and prefunctional checklists for systems, subsystems, and equipment to be verified and tested.
8. Step-by-step procedures for testing systems, subsystems, and equipment with descriptions for methods of verifying relevant data, recording the results obtained, and listing parties involved in performing and verifying tests.

B. Certificate of Readiness: Certificate of Readiness shall be provided and signed by Contractor, sub-contractor(s), and installer(s) for each system certifying that all subsystems, equipment, and associated controls are ready for testing. Completed startup plan checklists shall accompany this certificate.

1.10 QUALITY ASSURANCE

A. Test Equipment Calibration: Contractors shall comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 SYSTEMS TO BE COMMISSIONED

A. See specification sections 230800, Mechanical Commissioning Requirements and 260800, Electrical Commissioning Requirements for lists of systems and equipment to be commissioned.

3.2 STARTUP AND PRE-FUNCTIONAL CHECKLISTS

A. The following procedures apply to all equipment to be commissioned, according to Section 3.1, Systems to be Commissioned. Some systems that are not comprised so much of actual dynamic machinery, e.g., electrical system power quality, may have very simplified startup plans.

B. General: Startup and pre-functional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full pre-functional checkout. No sampling strategies are used. The startup and pre-functional checklists for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

C. Startup Plan: The CxA shall assist the commissioning team members responsible for startup of any equipment in developing detailed startup plans for all equipment. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.

1. The contractor responsible for the purchase of the equipment develops the full startup plan by combining (or adding to) the representative checklists and procedures from specifications 230800 and/or 260800 with the manufacturer's detailed startup and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and observations of each procedure and a summary statement with a signature block at the end of the plan.
2. The full startup plan could consist of something as simple as:
    a. The approved startup and checkout procedures and CxA-provided pre-functional checklists.
    b. The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
    c. The contractor's normally used field checkout sheets.
3. The contractor submits the full startup plan to the CxA for review and approval.
4. The CxA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
5. The approved startup plan is provided to the Contractor. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form will have more than one trade responsible for its execution.

D. Execution of Startup Plan

1. Four weeks prior to startup, the Contractors and vendors schedule startup and checkout with the CM and CxA. The performance of the startup plans is directed and executed by the Contractor. When checking off pre-functional checklists, signatures may be required of other Contractors for verification of completion of their work.

2. The Contractors and vendors shall execute the startup and provide the CxA with a signed and dated copy of the completed startup plans.

3. Only individuals that have direct knowledge and witnessed that a line-item task on the startup plan was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

4. Items left incomplete, which later cause deficiencies or delays during functional testing may result in backcharges to the responsible party.

3.3 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope: The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, no flow, equipment failure, etc. shall also be tested.

B. Development of Test Procedures. Before test procedures are written, the contractor shall provide the CxA with all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Using the provided data, the CxA will develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Contractor or vendor responsible to execute a test, shall provide limited assistance to the CxA in developing the procedures review (e.g. answering questions about equipment, operation, sequences, etc.). Prior to execution, the CxA shall provide a copy of the test procedures to the Commissioning Team to review for feasibility, safety, equipment and warranty protection. The CxA may submit the tests to the A/E for review, if requested.

C. Coordination and Scheduling: The Contractor shall provide sufficient notice to the CxA prior to commencement of any equipment/system startup, acceptance testing, observation, demonstrations, or other events which form a part of formal acceptance. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Contractors shall execute the tests. In general, functional testing is conducted after startup has been satisfactorily completed. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

D. Problem Solving. The CxA may recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Contractor and A/E.

E. Opposite Season Testing: Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. "Opposite season" testing will be required where scheduling prohibits thorough testing in all modes of operation.

3.4 DOCUMENTATION OF NON-CONFORMANCE AND APPROVAL OF TESTS

A. As tests progress and a deficiency is identified, the CxA discusses the issue with the executing contractor.

1. When there is no dispute on the deficiency and the Contractor accepts responsibility to correct it:

   a. The CxA documents the deficiency and the Contractor's intentions and testing proceeds.

   b. Once the Contractor has corrected the deficiency, the CxA shall be notified in writing that the issue has been FIXED certifying that the equipment is ready to be retested.

   c. The test is repeated and the deficiency status will be changed to either ACCEPTED to close the issue or, if the issue was not properly resolved, the issue status will be will changed back to OPEN.

2. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

   a. The deficiency shall be documented on the project commissioning issues log with the Contractor's response and issued to the Commissioning Team.

   b. Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority and acceptance authority is with the Owner.

   c. The CxA documents the resolution process on the project deficiency log.

   d. Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency and the CxA shall be notified in writing that the issue has been FIXED certifying that the equipment is ready to be retested. The test is repeated until satisfactory performance is achieved.

B. Cost of Retesting

1. For a deficiency identified, not related to any pre-functional checklist or startup fault, the following shall apply: The equipment will be retested once under the original contract. However, the CxA's time for a second retest will be charged to the Owner, who may choose to recover costs from the Contractor.

2. The time for the CxA to direct any retesting required because a specific pre-functional checklist or startup test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be charged to the Owner, who may choose to recover costs from the Contractor.

3. The Contractor shall respond in writing to the CxA at least as often as commissioning meetings are being scheduled concerning the status of each

apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.

4. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

C. Functional Test Approval: The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA. The CxA recommends acceptance of each test to the Owner using a standard form. The Owner gives final approval on each test using the same form, providing a signed copy to the CxA and the Contractor.

3.5 DEFERRED TESTING

A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the Owner. These tests will be conducted in the same manner as the seasonal tests as soon as possible.

END OF SECTION 019113

SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 01 10 00 "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 01 73 00 "Execution" for cutting and patching procedures.
3. Section 31 10 00 "Site Clearing" for site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

B. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

C. Pre-demolition Photographs or Video: Submit before Work begins.

1.7 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 WARRANTY

A. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

B. Existing Services/Systems to Be Remain: Where services and systems that are to remain are impacted by the removal or demolition of other work (i.e. removal of ceiling grid that support lights and/or diffusers), the Contractor shall restore the services and systems back to original operation and/or location using materials, supports, and requirements outlined in the project specifications without additional compensation.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly.

B. Removed and Salvaged Items:

1. Store items in a secure area until delivery to Owner.
2. Transport items to Owner's storage area designated by Owner.
3. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 10 00 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.

1.3 DEFINITIONS

A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.

B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Exposed surface form-facing material.
2. Concealed surface form-facing material.
3. Form ties.
4. Waterstops.
5. Form-release agent.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Laboratory Test Reports: For liquid floor treatments and curing and sealing compounds, indicating compliance with requirements for low-emitting materials.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete, and as follows:
   a. Plywood, metal, or other approved panel materials.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 RELATED MATERIALS

A. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

B. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners shall be acceptable to form liner manufacturer.

C. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete" for as-cast finishes .

C. Limit concrete surface irregularities as follows:

1. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. Do not chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
   a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Clean embedded items immediately prior to concrete placement.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

END OF SECTION 03 10 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 20 00 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site .

1. Review the following:
   a. Special inspection and testing and inspecting agency procedures for field quality control.
   b. Construction contraction and isolation joints.
   c. Steel-reinforcement installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Type III Environmental Product Declaration (EPD): For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

C. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of

mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of Architect.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For testing and inspection agency.

B. Welding certificates.

1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:
   a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage and to avoid damaging coatings on steel reinforcement.

1. Store reinforcement to avoid contact with earth.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

B. Reinforcing Bars: ASTM A615/A615M, Grade 60 , deformed.

C. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.2 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

C. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain .

2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.

2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
   a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches.
2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement welding.

D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 03 20 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete and vapor barrier, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 03 10 00 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 03 20 00 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site .

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete Subcontractor.
2. Review the following:
   a. Special inspection and testing and inspecting agency procedures for field quality control.
   b. Construction joints, control joints, isolation joints, and joint-filler strips.
   c. Semirigid joint fillers.
   d. Vapor-retarder installation.
   e. Anchor rod and anchorage device installation tolerances.

f. Cold and hot weather concreting procedures.
g. Concrete finishes and finishing.
h. Curing procedures.
i. Forms and form-removal limitations.
j. Methods for achieving specified floor and slab flatness and levelness.
k. Floor and slab flatness and levelness measurements.
l. Concrete repair procedures.
m. Concrete protection.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Silica fume.
5. Aggregates.
6. Admixtures:
   a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
7. Vapor retarders.
8. Curing materials.
9. Joint fillers.
10. Repair materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Laboratory Test Reports: For liquid floor treatments and curing and sealing compounds, indicating compliance with requirements for low-emitting materials.

C. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.

10. Intended placement method.
11. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   a. Location of construction joints is subject to approval of the Architect.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Bonding agents.
5. Adhesives.
6. Vapor retarders.
7. Semirigid joint filler.
8. Joint-filler strips.
9. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Silica fume.
5. Aggregates.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Field quality-control reports.

F. Minutes of preinstallation conference.

G. Submit photos of vapor barrier installation, including penetration detailing with time stamp taken 8 hours maximum prior to concrete placement.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician .

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Field Quality-Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.8 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
3. Obtain aggregate from single source.
4. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I/II , gray .
2. Fly Ash: ASTM C618, Class C or F.

3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Silica Fume: ASTM C1240 amorphous silica.

C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.

F. Water and Water Used to Make Ice: ASTM C94/C94M, potable

2.3 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A ; not less than 15 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Stego Industries, LLC.
   b. W. R. Meadows, Inc.

2.4 CURING MATERIALS

A. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:
   a. Ambient Temperature Below 50 deg F: Black.
   b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
   c. Ambient Temperature Above 85 deg F: White.

B. Water: Potable or complying with ASTM C1602/C1602M.

C. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B; to be used at locations denoted with floor finish other than sealed concrete per architectural documentation.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dayton Superior Corporation.
   b. Euclid Chemical Company (The); an RPM company.
   c. SpecChem, LLC.

D. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A; refer to architectural documentation for locations denoted to be sealed concrete finish or carpet tile for locations of use.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dayton Superior Corporation.
   b. Euclid Chemical Company (The); an RPM company.
   c. SpecChem, LLC.
2. Verify products comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.

B. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

C. Floor Slab Protective Covering: 8-feet- wide cellulose fabric.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. McTech Group, Inc.

2.6 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.

2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.7 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use water-reducing admixture in concrete, as required, for placement and workability.
2. Use water-reducing admixture in pumped concrete, and concrete with a w/cm below 0.50.

2.8 CONCRETE MIXTURES

A. Class A : Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: ACI 318 F2 .
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Maximum Dry Shrinkage in Accordance with ASTM C157: 0.05%
4. Slump Limit: 8 inches , plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site .
5. Air Content:
   a. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size .
6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

B. Class C : Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: ACI 318 C0 .
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Maximum Dry Shrinkage in Accordance with ASTM C157: 0.05%
4. Minimum Cementitious Materials Content: 540 lb/cu. yd. .
5. Slump Limit: 8 inches , plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site .
6. Air Content:
   a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.

3.4 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
4. Lap joints 6 inches and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.
   a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.5 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.
   a. Continue reinforcement across construction joints unless otherwise indicated.
   b. Do not continue reinforcement through sides of strip placements of floors and slabs.
3. Space vertical joints in walls spaced at 20 feet maximum . Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 07 92 00 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
    a. Do not use vibrators to transport concrete inside forms.
    b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
    c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
   a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
   b. Remove projections larger than 1/4 inch.
   c. Patch tie holes.
   d. Surface Tolerance: ACI 117 Class B.
   e. Locations: Apply to concrete surfaces exposed to public view, .
2. ACI 301 Surface Finish SF-3.0:
   a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
   b. Remove projections larger than 1/8 inch.
   c. Patch tie holes.
   d. Surface Tolerance: ACI 117 Class A.
   e. Locations: Apply to concrete surfaces to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete .

B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:
   a. Perform no later than one day after form removal.
   b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
   c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
   d. Maintain required patterns or variances as shown on Drawings or to match design reference sample .

C. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
3. Apply scratch finish to surfaces to receive concrete floor toppings .

C. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo .

D. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system .
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:
   a. Slabs on Ground:

1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch .

b. Suspended Slabs:

1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch .

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces . While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish with Architect before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 12-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
   a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   b. Cast anchor-bolt insert into bases.

c. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.10 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
   a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
   b. Continuous Sprinkling: Maintain concrete surface continuously wet.
   c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
   d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
   e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
      1) Recoat areas subject to heavy rainfall within three hours after initial application.
      2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:
   a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
      1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
         a) Lap edges and ends of absorptive cover not less than 12 inches.

b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
   a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
   b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
   a) Water.
   b) Continuous water-fog spray.

b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
   a) Lap edges and ends of absorptive cover not less than 12 inches.
   b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
   a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
   b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
   a) Water.
   b) Continuous water-fog spray.

c. Floors to Receive Polished Finish: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
   a) Lap edges and ends of absorptive cover not less than 12 inches.
   b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
   a) Water.
   b) Continuous water-fog spray.

d. Floors to Receive Chemical Stain:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
3) Butt sides of curing paper tight; do not overlap sides of curing paper.
4) Leave curing paper in place for duration of curing period, but not less than 28 days.

e. Floors to Receive Urethane Flooring:
1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Curing Compound:
1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

g. Floors to Receive Curing and Sealing Compound:
1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.11 TOLERANCES

A. Conform to ACI 117.

3.12 JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month(s).
2. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
   a. Limit cut depth to 3/4 inch.
   b. Make edges of cuts perpendicular to concrete surface.
   c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
   d. Fill and compact with patching mortar before bonding agent has dried.
   e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
   a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
   b. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
   a. Correct low and high areas.
   b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
    a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
    a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    b. Feather edges to match adjacent floor elevations.
6. Correct other low areas scheduled to remain exposed with repair topping.
    a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
    b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
    a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
    b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    d. Place, compact, and finish to blend with adjacent finished concrete.
    e. Cure in same manner as adjacent concrete.
8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
    a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    b. Dampen cleaned concrete surfaces and apply bonding agent.
    c. Place patching mortar before bonding agent has dried.
    d. Compact patching mortar and finish to match adjacent concrete.
    e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency to be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
    a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
        1) Project name.
        2) Name of testing agency.
        3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
        4) Name of concrete manufacturer.
        5) Date and time of inspection, sampling, and field testing.
        6) Date and time of concrete placement.
        7) Location in Work of concrete represented by samples.
        8) Date and time sample was obtained.
        9) Truck and batch ticket numbers.
        10) Design compressive strength at 28 days.
        11) Concrete mixture designation, proportions, and materials.
        12) Field test results.
        13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
        14) Type of fracture and compressive break strengths at seven days and 28 days.

C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
   a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C143/C143M:
   a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   b. Perform additional tests when concrete consistency appears to change.
3. Slump Flow: ASTM C1611/C1611M:
   a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   b. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; .
   a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M:
   a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Compression Test Specimens: ASTM C31/C31M:
   a. Cast and laboratory cure five 4 4-inch by 8cylinders. cylinder specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C39/C39M.
   a. Test one laboratory-cured specimens at seven days and one set of three specimens at 28 days.
   b. A compressive-strength test to be the average compressive strength from a set of three specimens obtained from same composite sample and tested at age indicated.
8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests:
    a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
   1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.6.6.3.

12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.15 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 03 30 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 04 22 00 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry-joint reinforcement.
5. Miscellaneous masonry accessories.

B. Related Requirements:

1. Section 07 19 00 "Water Repellents" for water repellents applied to unit masonry assemblies.
2. Section 07 62 00 "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
3. Section 08 95 16 "Wall Vents" for wall vents (brick vents).

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site .

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.

2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.
   a. Include data on material propertiesandmaterial test reports substantiating compliance with requirements.
   b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
2. Integral water repellant used in CMUs.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 602/ACI 530.1/ASCE 6.

E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost

or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet vertically and horizontally of a walking surface.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.3 CONCRETE MASONRY UNITS

A. Regional Materials: Verify CMUs are manufactured within 100 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.

B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners unless otherwise indicated.

C. Integral Water Repellent: Provide units made with integral water repellent for exposed units and where indicated.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.
   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Acme Brick Company.
      2) Euclid Chemical Company (The); a subsidiary of RPM International, Inc.
      3) GCP Applied Technologies Inc.

D. CMUs: ASTM C90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi .
2. Density Classification: Normal weight .
3. Size (Width): Manufactured to dimensions 3/8 inch less-than-nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
5. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

2.4 MASONRY LINTELS

A. General: Provide one of the following:

B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars

placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.5 MORTAR AND GROUT MATERIALS

A. Regional Materials: Manufacture aggregate for mortar and grout , cement, and lime within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.

B. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content is not more than 0.1 percent when tested in accordance with ASTM C114.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C91/C91M.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cemex S.A.B. de C.V.
   b. Holcim (US) Inc.
   c. Lafarge North America Inc.

E. Mortar Cement: ASTM C1329/C1329M.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Lafarge North America Inc.

F. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Aggregate for Grout: ASTM C404.

H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ACM Chemistries.
   b. Euclid Chemical Company (The); a subsidiary of RPM International, Inc.
   c. GCP Applied Technologies Inc.

I. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Heckmann Building Products, Inc.
   b. Hohmann & Barnard, Inc.
   c. Wire-Bond.

C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951/A951M.

1. Interior Walls: Hot-dip galvanized carbon steel.
2. Wire Size for Side Rods: 0.187-inch diameter.
3. Wire Size for Cross Rods: 0.187-inch diameter.
4. Spacing of Cross Rods: Not more than 16 inches o.c.
5. Provide in lengths of not less than 10 feet , with prefabricated corner and tee units.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 or PVC, complying with ASTM D2287, Type PVC-

65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.8 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime masonry cement or mortar cement mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S .
3. For mortar parge coats, use Type S or Type N.
4. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior nonload-bearing partitions, Type O may be used instead of Type N.

D. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 3000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that would impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond ; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive

mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.
3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 07 84 43 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Rake out mortar joints at pre-faced CMUs to a uniform depth of 1/4 inch and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

3.9 LINTELS

A. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches .

3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements is done at Contractor's expense.

B. Inspections: Special inspections in accordance with Level B in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at 28 days.

3.12 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.13 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.14 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 31 20 00 "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 22 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Load-bearing wall framing.
2. Floor joist framing.
3. Ceiling joist framing.

B. Related Requirements:

1. Section 09 22 16 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site .

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Cold-formed steel framing materials.
2. Load-bearing wall framing.
3. Floor joist framing.
4. Ceiling joist framing.
5. Power-actuated anchors.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

D. Delegated Design Submittal: For cold-formed steel framing.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of code-compliance certification for studs and tracks.

C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency .

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

D. Research Reports:

1. For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
2. For sill sealer gasket/termite barrier, showing compliance with ICC-ES AC380.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency , or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association the Steel Framing Industry Association the Steel Stud Manufacturers Association or the Supreme Steel Framing System Association.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

E. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ClarkDietrich.
2. Steel Network, Inc. (The).

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design cold-formed steel framing.

B. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and AISI S240.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with AISI S240 for conditions indicated.

C. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: ST33HandST50Has indicated on drawings .
2. Coating: G60 , A60 , AZ50 , or GF30 .

D. Steel Sheet for Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 50 , Class 1 .
2. Coating: G60 .

2.4 LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch .
2. Flange Width: 2 inches .

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs .
2. Flange Width: 1-1/4 inches .

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch .
2. Flange Width: 2 inches .

2.5 FLOOR JOIST FRAMING

A. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch .
2. Flange Width: 2 inches , minimum.

B. Steel Joist Track: Manufacturer's standard U-shaped steel joist track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel joists .
2. Flange Width: 2 inches , minimum.

2.6 CEILING JOIST FRAMING

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch .
2. Flange Width: 2 inches , minimum.

2.7 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Bracing, bridging, and solid blocking.
2. Web stiffeners.
3. Joist hangers and end closures.

2.8 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

B. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

D. Welding Electrodes: Comply with AWS standards.

2.9 MISCELLANEOUS MATERIALS

A. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

2.10 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.

3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
   a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
   a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF LOAD-BEARING WALL FRAMING

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:

1. Anchor Spacing: As shown on Shop Drawings .

B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch between the end of wall-framing member and the web of track.

1. Fasten both flanges of studs to top and bottom tracks.
2. Space studs as follows:

a. Stud Spacing: As indicated on Drawings .

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.
2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced vertically as indicated on Shop Drawings . Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches deep.
2. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

J. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION OF JOIST FRAMING

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.

C. Space joists not more than 2 inches from abutting walls, and as follows:

1. Joist Spacing: As indicated on Drawings .

D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.

1. Install web stiffeners to transfer axial loads of walls above.

F. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:

1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.6 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.7 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.8 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for mechanical and electrical equipment.
2. Metal ladders.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for installing anchor bolts and other items cast into concrete.
2. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. OSHA 1910.27 – Fixed Ladders.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Shop Drawings and Product Data: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide reaction loads for each hanger and bracket.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer qualified for designing stair in state and municipal codes and design standards.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Manufacturer Qualifications: A firm experienced in producing aluminum metal ladders similar to those indicated for this Project and capable of engaging a professional engineering competent in design and structural analysis to fabricate ladders in compliance with industry standards and local codes.

D. Product Qualification: Product design shall comply with OSHA 1910.27 minimum standards for ladders.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Provide O'Keeffe's 520A 60 degree or one of the following:

1. Erect A Step
2. ALACO
3. FS Industries
4. Approved equal submitted during bid process.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Steel Hollow Structural Section: ASTM A500 Gr. B

E. Abrasive-Surface Floor Plate: Aluminum plate with abrasive surface.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.3 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

H. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.4 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

2.5 METAL SHIPS' LADDERS

A. Provide metal ships' ladders where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Treads shall be not less than 4 inches , and riser height shall be 6 ½” minimum to 12” maximum, width of 24”.
2. Fabricate ships' ladders, including railings from aluminum 1 ½” round, 12” above stringer, 42” height at top step.
3. Slope of stair stringer to be 60 degrees.

2.6 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Prime exterior miscellaneous steel trim with primer specified in Section 09 96 00 "High-Performance Coatings."

2.7 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.8 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items exposed to the exterior to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

2.9 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 50 00

SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wood blocking.
2. Plywood Flooring at Above-ceiling Services Access Over Metal Joist Framing.

1.3 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

1.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

1.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

1.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

END OF SECTION 06 10 00

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Foam-plastic board insulation.
2. Foam-plastic board insulation with concrete facing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For concrete-faced insulation board – 6”x6” minimum sample.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
3. Quickly complete installation and concealment of exposed foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. DiversiFoam Products.
   b. Dow Chemical Company (The).
   c. Owens Corning.
   d. Kingspan Insulation LLC.
   e. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2. Type VI, 1.8 pcf min. density at installations below grade, and/or supporting backfill.

2.2 CONCRETE-FACED INSULATED PERIMETER WALL PANELS

A. Extruded polystyrene insulation with 5/8" latex modified concrete face; tongue and groove edges. Foam R value of 5 per inch; compressive strength 40 pounds per square inch. Secure to perimeter concrete with manufacturer mechanical attachment system.

1. Products: Provide from basis of design manufacturer or approved equal:

   a. Wallguard, T Clear Corporation
   b. CFI – Tech-Creet Processors LTD.
   c. Sopra XPS Protect Artic C – Soprema.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF BELOW-GRADE INSULATION

A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 36 inches (915 mm) below exterior grade line.

3.4 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 13 34 19 “Metal Buildings Systems” for coordination at expansion joint; wall flashings, roof penetrations, and trims.

1.2 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.

9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
10. Include details of special conditions.
11. Include details of connections to adjoining work.

C. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Flashing and Trims: Refer to requirements in Section 13 34 19.

1.4 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Same requirements listed in Section 13 34 19.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

2.3 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry,

metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
2. Obtain field measurements for accurate fit before shop fabrication.
3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

D. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

E. Sealant Joints: Where movable, non-expansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

G. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

H. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
4. Torch cutting of sheet metal flashing and trim is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches (600 mm) of corner or intersection.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.

D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

E. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.3 ROOF-DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

3.4 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.5 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.

E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 07 72 53 - SNOW GUARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for snow guards.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

1. Include calculation of number and location of snow guards based on snow load, roof slope, roof type, components, spacings, and finish.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Structural Performance:

1. Snow Loads: As indicated on Structural Drawings.

2.2 SNOW GUARDS – CLAMP AND RAIL

A. Provide system with bar rail, pressure clamped to standing seam with no penetrating fasteners and intermediate snow/ice stops between standing seams:

1. Material: Manufacturer's standard noncorrosive metal.

2. Product: Metal Roof Snowguards, SnoBar or equal approved by Metal Building System Manufacturer to not void finish or weathertightness warranties.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates including compatibility with existing finishes or primers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates for bonding snow guards.

B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.

B. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing, or fastening methods that void metal roofing finish or weathertightness warranty.

END OF SECTION 07 72 53

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Nonstaining silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.

B. Related Requirements:

1. Section 32 13 73 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Provide color selection samples from manufacturer's standard range.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.6 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:

1. Architectural sealants shall have a VOC content of 250 g/L or less.
2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 URETHANE JOINT SEALANTS

A. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.

B. Silicone, Nonstaining, S, NS, 100/50 NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

1. Products: Subject to compliance with requirements, provide the following or approved equal:

a. Pecora Corporation; 890FTS/TXTR.

2.4 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920,.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Adfast.
b. GE Construction Sealants; Momentive Performance Materials Inc.

c. May National Associates, Inc.; a subsidiary of Sika Corporation.
d. Pecora Corporation.
e. Soudal USA.
f. The Dow Chemical Company.
g. Tremco Incorporated.

2.5 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

2.6 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330. As approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Porcelain enamel.
    c. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates as recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or

by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

G. Location of joint sealant shall include all areas noted on the drawings and shall also include the following specific areas.

1. At perimeter and bottom of all hollow metal door frames in gypsum, and concrete masonry unit walls.
2. At connection of all dissimilar materials including but not limited to; gypsum drywall to concrete, gypsum drywall to masonry, concrete to masonry, steel to gypsum drywall, steel to masonry, steel to concrete, etc.

3. At perimeter of all accessory items mounted in concrete, gypsum drywall and masonry surfaces including, but not limited to; toilet accessories, fire extinguisher cabinets, etc.
4. At perimeter of all millwork as it abuts any wall surface unless directed by the Architect.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Sealant: Urethane T.
2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

    a. Construction joints in cast-in-place concrete.
    b. Control and expansion joints in unit masonry.
    c. Joints between metal panels.
    d. Joints between different materials listed above.
    e. Perimeter joints between materials listed above and frames of doors and storefront.

2. Joint Sealant: Urethane 50 NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

3.7 Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.

1. Joint Locations:

   a. All interior joints not otherwise indicated.

2. Joint Sealant: Acrylic latex.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

   a. Joints between adjoining walls and plumbing fixture, floors, door frames, wall penetrations, fixed casework,
   b. Tile joints.

2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 92 00

SECTION 07 95 00 - EXPANSION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Exterior wall expansion control systems.

B. Related Requirements:

1. Section 07 92 00 "Joint Sealants" for liquid-applied joint sealants and elastomeric sealants without metal frames.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For each expansion control system specified. Include plans, elevations, sections, details, splices, attachments to other work, and line diagrams showing entire route of each expansion control system. Where expansion control systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

B. Samples: For each exposed expansion control system and for each color and texture specified, full width by 6 inches long in size.

C. Color Selection: For each exposed joint finish face provide manufacturer's standard colors for selection approval.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each fire barrier provided as part of an expansion control system, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. General: Provide expansion control systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.

1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where expansion control systems change direction or abut other materials.
2. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion control systems.

B. Coordination: Coordinate installation of exterior wall expansion control systems with roof expansion control systems to ensure that wall transitions are watertight. Roof expansion joint assemblies are specified elsewhere.

2.2 EXTERIOR WALL EXPANSION CONTROL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Emseal Corporation.
2. InPro Products
3. Tremco
4. Construction Specialties
5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Basis-of-Design Product: Emseal Colorseal – silicone-coated, pre-compressed primary seal with 100% joint movement (50% each way).

C. Source Limitations: Obtain expansion control systems from single source from single manufacturer.

2.3 MATERIALS

A. Compression Seals: ASTM E 1612; preformed elastomeric extrusions having an internal baffle system and designed to function under compression.

B. Cellular Foam Seals: Extruded, compressible foam designed to function under 50% compression and 50% tension.

2.4 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion control systems will be installed for installation tolerances and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion control system manufacturer's written instructions.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion control systems and materials unless more stringent requirements are indicated.

B. Foam Seals: Install with adhesive recommended by manufacturer.

C. Terminate exposed ends of expansion control systems with field- or factory-fabricated termination devices.

3.4 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion control systems. Reinstall cover plates or seals prior to Substantial Completion of the Work.

END OF SECTION 07 95 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes hollow metal work.

B. Related Requirements:

1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.
2. Section 09 91 13 “Exterior Painting” for coordination and compatibility of shop prime coating with field-applied top coatings.
3. Section 09 96 00 “High-Performance Coatings” for coordination and compatibility of shop prime coating with field-applied top coatings.
4. Section 08 16 13 “Fiberglass Reinforced Plastic (FRP) Doors” for non-hollow metal doors in hollow metal frames.
5. Section 08 71 00 “Door Hardware” for door hardware.

1.3 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.

3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

C. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ceco Door Products; an Assa Abloy Group company.
2. Curries Company; an Assa Abloy Group company.
3. Republic Doors and Frames.
4. Steelcraft; an Ingersoll-Rand company.

5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: SDI A250.8, Level 3. All interior locations.

1. Physical Performance: Level B according to SDI A250.4.

2. Doors:

   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches .
   c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.053 inch .
   d. Edge Construction: Model 2, Seamless.
   e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, core at manufacturer's discretion.

3. Frames:

   a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch .
   b. Construction: Full profile welded.

4. Exposed Finish: Prime paint at ferrous metal, #4 brushed satin at stainless steel.

2.3 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3. All exterior locations.

1. Physical Performance: Level A according to SDI A250.4.
2. Doors:

   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches

c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch , with minimum A40 coating.
d. Edge Construction: Model 2, Seamless.
e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
f. Core: Polyurethane.

1) Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.

3. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch , with minimum A40 coating.
b. Construction: Full profile welded.

4. Exposed Finish: Factory.

2.4 HOLLOW-METAL PANELS

A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
4. Post-installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.6 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

E. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

F. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

G. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

H. Glazing: Comply with requirements in Section 08 80 00 "Glazing."

2.7 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

1. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches .
2. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.
3. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
4. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
2. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
4. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:

        1) Three anchors per jamb from 60 to 90 inches high, four from 90 to 120 inches.

    b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

        1) Four anchors per jamb from 60 to 90 inches high, five from 90 to 120 inches.

    c. Compression Type: Not less than two anchors in each frame.
    d. Post-installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

5. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

F. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
3. Provide loose stops and moldings on inside of hollow-metal work.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.8 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply primer compatible with top-coatings to be field-painted and coordinated with painting and coating sections withing this project manual.

1. Shop Primer: Prime coating coordinated with intended field-applied top coatings, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure. Primer to be compatible with finish coat; refer to finish schedule and related paint and coating specification sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    b. Install frames with removable stops located on secure side of opening.
    c. Install door silencers in frames before grouting.
    d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    e. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.

3. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch , measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch , measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch , measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch , measured at jambs at floor.

C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

    a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch .
    b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
    c. At Bottom of Door: 3/4 inch plus or minus 1/32 inch

d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch

D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

F. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 08 16 13 – FIBERGLASS-REINFORCED POLYMER (FRP) DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 08 11 13 "Hollow Metal Doors and Frames".

C. Section 08 71 00 "Door Hardware".

1.2 QUALITY ASSURANCE

A. Construction: Verify that FRP doors and frames are manufactured utilizing pultruded fiberglass components.

B. Resins: Resins shall comply with USDA and FDA standards for incidental food contact

C. Flame Spread Rating: Flame retardant structural shapes meet the minimum flame spread rating less than or equal to 25 when tested according to ASTM E84.

D. Physical Endurance: FRP Doors and frames to successfully complete 1,000,000 cycles Grade A swing test in compliance with ANSI/SDI A250.4-2011.

E. Impact Strength: FRP doors 10.32 foot-pounds per inch, ASTM D-256.

F. Tensile Strength:

1. FRP doors 12,000 psi, ASTM D-638.
2. FRP frames 30,000 psi, ASTM D-638.

G. Flexural Strength: FRP doors and frames 25,000 psi, ASTM D-790.

H. Compressive Strength:

1. FRP doors 18,000 psi, ASTM D-695.
2. FRP frames 30,000 psi, ASTM D-695.

I. Water Absorption: FRP doors and frames .27%, ASTM D-570.

J. Hardware Reinforcements: FRP doors and frames fabricated with a minimum screw holding strength of 1,000 lbs. Tested with a #12 x 1-1/4" hinge screw.

K. Warranty: Life of the initial installation against failure due to corrosion. Additionally, lifetime warranty against failure due to materials and workmanship from date of substantial completion.

1.3 SUBMITTALS

A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details and finishes.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver doors and frames crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Inspect doors and frames on delivery for damage and notify shipper and supplier if damage exists. Minor damages may be repaired provided refinished items match new work and are acceptable to the Architect. Remove and replace damaged items that cannot be repaired as directed.

C. Store doors and frames at building site under cover. Avoid using non-vented plastic or canvas covers that could create a humidity chamber.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FRP Architectural Doors Inc.
2. Weiland
3. Special-Lite, Inc.
4. Others submitted and approved by Architect prior to bid submittal.

B. Interior Doors: Provide doors complying with requirements indicated below:

1. CF34 (Heavy Duty).
2. Doors to have at least two internal full height vertical FRP stiffeners for warp resistance.
3. Polystyrene foam core standard.

C. Vision Lite Systems: Lite cutout shall be built-in during door assembly, utilizing FRP tubing.

.

2.2 FABRICATION

A. General: Fabricate fiberglass door and frame units to be rigid and free from defects including warp and buckle.

B. Core Construction: Manufacturer's standard core construction that complies with the following:

1. Expanded polystyrene or polyurethane foam core.
2. Fire resistant mineral core.

C. Stiles and Rails: Fabricate doors using FRP pultrusions.

D. Door Faces: Fiberglass face skins shall be fused to the stile and rail assembly, including the vertical stiffeners and core material, utilizing polyurethane adhesive.

E. Clearances: Not more than 1/8" at jambs and heads. Not more than 1/4" between pairs of doors. Not more than 3/4" at bottom unless indicated otherwise.

F. Door Edges: Lock stile to be factory beveled 3 degrees, standard.

G. Tolerances: Maximum diagonal distortion 1/8" measured with straight edge, corner-to-corner.

H. Hardware Reinforcement: Fabricate all hardware reinforcements using FRP pultrusions.

I. Exposed Fasteners: Unless otherwise indicated, provide stainless steel, countersunk flat or oval heads for exposed screws and bolts.

J. Hardware Preparations: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier.

K. Hardware Locations: Locate hardware as indicated on shop drawings or, if not indicated, according to manufacturer's standard locations.

L. Glazing Stops: Two-piece PVC lite kits.

1. Provide screw-applied, removable, glazing stops on inside of opening, louvers, and other panels in doors.
2. Glass to be supplied and installed under section 08800, unless stated otherwise.

2.3 FINISHES

A. Two-component acrylic urethane topcoat custom color, factory-finished.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General: Install FRP doors, frames, and accessories according to shop drawings, manufacturer's data, and as specified.
B. Placing Frames: Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set.

1. Except for frames located in existing walls, place frames before construction of enclosing walls and ceilings.
2. In masonry construction, provide at least three wall anchors per jamb; install adjacent to hinge locations on hinge jamb and at corresponding heights on strike jamb**, u**tilizing masonry wire anchors.
3. In existing concrete or masonry construction, provide at least three completed opening anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with stainless steel expansion bolts.
4. For openings 90" or more in height, install an additional anchor at hinge and strike jambs.

C. Factory Finished Doors: Restore finish before installation if fitting or machining is required at Project site.
D. Door Installation: Fit fiberglass doors accurately in frames. Shim as necessary.

END OF SECTI`ON 08 16 13

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Access doors and frames for walls and ceilings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Detail fabrication and installation of access doors and frames for each type of substrate.

C. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. J. L. Industries, Inc.; Div. of Activar Construction Products Group.
2. Larsen's Manufacturing Company.
3. Milcor Inc.

4. Acudor
5. Cendrex
6. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

C. Flush Access Doors with Concealed Flanges :

1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum boardbeads for concealed flange installation.
2. Locations: Ceiling
3. Door Size: 24x24".

a. Finish: Factory finish.

D. Hardware:

1. Latch: Cam latch operated by screwdriver.

2.2 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

C. Frame Anchors: Same type as door face.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.

2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded metal lath and exposed casing bead welded to perimeter of frames.
3. Provide mounting holes in frames for attachment of units to metal or wood framing.
4. Provide mounting holes in frame for attachment of masonry anchors.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.

1. For recessed doors with plaster infill, provide self-furring expanded metal lath attached to door panel.

E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

1. For cylinder locks, furnish two keys per lock and key all locks alike.
2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

F. Extruded Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.4 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13

SECTION 08 41 13 – ALUMINUM-FRAMED STOREFRONTS

PART 1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Exterior and storefront framing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:

a. Joinery, including concealed welds.
b. Anchorage.
c. Expansion provisions.
d. Glazing.
e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

1.4 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: Ten (10) years from date of Substantial Completion.

PART 2. PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

a. Thermal stresses transferring to building structure.
b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.
d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.

B. Structural Loads:

1. Wind Loads: As indicated on Drawings.

C. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:

1. Fixed Framing and Glass Area:

a. Maximum air leakage of 0.06 cfm/sq. ft. at a static air-pressure differential of 1.57 lbf/sq. ft.

D. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.

E. Energy Performance: Certify and label energy performance according to NFRC as follows:

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
2. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 45 as determined according to NFRC 500.

F. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer 451T Storefront System or comparable product by one of the following:

1. EFCO Corporation.
2. Manko Window Systems.
3. Tubelite.

4. Or approved equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.3 FRAMING

A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: Thermally broken.
2. Glazing System: Retained mechanically with gaskets on four sides.
3. Glazing Plane: Front.
4. Finish: Clear anodic finish
5. Fabrication Method: Field-fabricated stick system.

B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.

D. Materials:

1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

a. Sheet and Plate: ASTM B 209.
b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 .
c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
d. Structural Profiles: ASTM B 308/B 308M.

2.4 GLAZING

A. Glazing Comply with Section 08 80 00 "Glazing".

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L.

2.5 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

C. Concealed Flashing: Manufacturer's standard corrosion-resistant, non-staining, nonbleeding flashing compatible with adjacent materials.

D. Bituminous Paint: Cold-applied asphalt mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed form view to greatest extent possible.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3. EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed to produce weathertight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install glazing as specified in Section 08 80 00 "Glazing."

F. Install weather seal sealant according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

G. Provide end dams at all window systems.

END OF SECTION 08 41 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 08 71 11 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes finish hardware for the proper operation and control of all doors in the Project. Prior to bidding, notify Architect of any doors that do not have hardware meeting this intention.

B. Hardware supplier will be responsible to furnish and install hardware on labeled doors to satisfy State and Local Building Codes.

C. Related Sections include the following:

1. Division 8 Section "Hollow Metal Doors and Frames."
2. Division 8 Section "Fiberglass-reinforced Polymer Doors."

1.3 SUBMITTALS

A. Product Data: For each product and material indicated, submit manufacturer's technical product data. Include information necessary to show compliance with requirements, installation instructions and maintenance instructions.

B. Hardware Schedule: Submit a hardware schedule organized into sets, including the information below. Designations for door numbers and hardware sets shall match those used in the construction documents.

1. Opening Number
2. Door Type and Size
3. Frame Type and Size
4. Frame Anchoring Method
5. Hardware Set
6. Assembly Rating

C. Hardware Schedule shall be coordinated with the doors, frames and related work to ensure proper size, thickness, hand function and finish of door hardware

1.4 QUALITY ASSURANCE

A. Supplier Qualifications: A recognized Architectural Finish Hardware Supplier, with warehous-

ing facilities, who has been furnishing hardware in the Project's vicinity for a period of not less than two (2) years. Supplier shall be or employ an experienced Architectural Hardware Consultant (AHC) who is certified by and member of the Door and Hardware Institute. The Architectural hardware Consultant shall be available, at reasonable times during the course of the work, for consultation about Project's hardware requirements, to Owner, Architect and Contractor.

B. Fire-Rated Openings: Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80, No. 101 and local building code requirements. Provide only hardware, which has been tested and listed, by UL, FM or Warnock Hersey for types and sizes of doors required and complies with requirements of door and door frame labels.

C. Standards: Comply with the requirements of the latest edition of the following standards unless indicated otherwise:

1. American National Standards Institute Publications:
   a. A115 Series – Door and Frame Preparation
   b. A156 Series – Hardware
2. Builders Hardware Manufacturer's Association Publications:
   a. 1201 – Auxiliary Hardware
   b. 1301 – Materials and Finishes
3. Door and Hardware Institute Publications:
   a. Keying – Procedures, Systems and Nomenclature
   b. Abbreviations and Symbols
   c. Hardware for Labeled Fire Doors
   d. Recommended Locations for Builder's Hardware for Standard and Custom Steel Doors and Frames
   e. Wood Door Standards W1, W2, WDHS-2, WDHS-3
4. National Fire Protection Association Publications
   a. NFPA 80 – Standards for Fire Doors and Windows
   b. NFPA 101 – Life Safety Code
5. International Building Code – 2015 Edition
6. American with Disabilities Act.

D. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Inspect and discuss preparatory work performed by other trades.
3. Inspect and discuss electrical roughing-in for electrified door hardware.
4. Review sequence of operation for each type of electrified door hardware.
5. Review required testing, inspecting, and certifying procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Package each hardware item in separate containers with all screws, wrenches, installation instructions and installation templates. Mark each box with hardware heading and door number according to approved hardware schedule.

B. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation: Provide a complete packing list showing items, door numbers and hardware headings with each shipment.

C. Store hardware in shipping cartons above ground and under cover to prevent damage. Provide secure lockup for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable -so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with delivery and/or installation when ambient and substrate temperature conditions are outside limits permitted by material manufacturers.

1.7 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

PART 2 - PRODUCTS

2.1 HARDWARE GENERAL

A. Provide the materials of products indicated by trade names, manufacturer’s name, or catalog number. Substitutions will not be permitted except as described in Division 1.

B. Provide manufacturer’s standard products meeting the design intent of this Specification, free of imperfections affecting appearance or serviceability.

1. Provide hardware complete with all fasteners, anchors, instructions, layout templates, and any specialized tools as required for satisfactory installation and adjustment.
2. Hand of Door: Drawings show direction of slide, swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.
3. Furnish screws for installation with each hardware item. Provide Phillips flat head screws except as otherwise indicated or approved. Finish screws exposed under any condition to match hardware finish, or, if exposed in surface of other work, to match finish of such other work as closely as possible. Use machine screws for metal con-

nections and wood screws for connections to wood. Use manufacturer's screws to secure hardware.

4. Provide concealed fasteners for hardware unit with care exposed when door is closed, except to extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt, head or nut on opposite face is exposed in other work, except where indicated otherwise or where it is not feasible to adequately reinforce the work. In such cases, provide sleeves for each thru-bolt or use sex screw fasteners.
5. Special Tools: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance and removal and replacement of finish hardware.

C. Hardware is specified in the hardware schedule by set, type and functions, which have been selected as best meeting the application requirements. Acceptable products for each category are specified in Paragraph 2.5 "Hardware Products".

2.2 SPECIAL REQUIREMENTS

A. General:
1. Where new doors and hardware are scheduled to be installed in existing frames, contractor to coordinate hinge sizes and locations, lockset backsets, strikes, hardware mounting heights, etc with existing frames to ensure new door and hardware fits and functions properly in existing frame.

B. Hinges:
1. Use heavy weight hinges for all doors.
2. Provide non-removable pins for all exterior doors and out-swinging corridor doors. Use nonrising pins for all other doors.
3. Pre-drill pilot holes for hinge fasteners at factory to suit hinge type.

C. Locksets:
1. Locksets to be grade 1 heavy duty cylindrical or as specified.

D. Exit Devices:
1. All latchbolts to be deadlatching type.
2. All touchbars to be stainless steel.
3. Devices are to incorporate a flush and tapered end cap.
4. Devices incorporating plastic dogging components will not be allowed.
5. Provide electrical options as specified.

E. Closers:
1. Comply with manufacturer's recommendations for unit size based on door size and usage.
2. Provide parallel arms for all overhead closers, except as otherwise indicated.
3. All closers UL Listed Certified to be in compliance with UBC 7.2 and UL 10C.
4. Closers with Pressure Relief Valves will not be acceptable.
5. Provide any brackets or plates required for proper installation of door closers.

F. Stops
1. Provide heavy duty and concealed or surface mounted overhead stop or holder for interior doors as specified. Provide overhead stop for interior doors that swing more than opens against equipment, casework, sidelights, and where conditions do not allow wall stop.

G. Thresholds and Gasketing
1. Provide thresholds, weatherstripping (including door sweeps, seals, astragals) and gasketing systems (including smoke, sound, and light) as specified and per architectural details. Match finish of other items.
2. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
3. Gasketing and astragals on aluminum frames by door manufacturer.

2.3 KEYING

A. Contractor to turn all cylinders over to MU key shop for keying.

2.4 FINISHES

A. Standard: Comply with BHMA A156.18
1. All door hardware to be US26D/630 throughout project.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the application units of hardware.

C. Protect finishes on exposed surfaces from any damage by applying a strippable temporary protective covering before shipping.

D. BHMA Designations: Comply with base material and finish requirements indicated by BHMA standards.

2.5 HARDARE PRODUCTS

ITEM	SPECIFIED	APPROVED EQUAL
Hinges	Ives	Stanley
Locksets	Best	Schlage, Sargent
Cylinders	Best	No Substitutions
Closers	LCN	No Substitutions
Panic Devices	Von Duprin	Sargent, Precision
Flatgoods	Ives	Burns, Rockwood
Stops	Ives	Burns, Rockwood
Overhead Stops	Glynn Johnson	Rixson

Gasket	Zero	NGP, Reese

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames with installer present for compliance with the requirements, for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine rough-in for electrical source power to verify actual locations of wiring connections before electrified door hardware installation.

C. Notify Architect of any discrepancies or conflicts between the door schedule, door types, frame types, drawings, scheduled hardware and built condition.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Frames: Comply with ANSI/DHI A115 Series

B. Wood Doors: Comply with ANSI/DHI A115-W Series.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated in the following applicable publications, or as required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builder's Hardware for Custom Steel Doors and Frames."
3. Wood Doors: DHI WDHS.2 "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to complete with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage and reinstallation of surface protective trim units to with finishing work. Do not install surface mounted items until finishes have been completed on substrates involved.

3.4 FIELD QUALITY CONTROL

A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in written report whether work complies with or deviates from requirements, including whether

door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating items of door hardware and each door to ensure proper operation of function of every unit. Replace units that cannot be adjusted to operate as intended and/or required. Adjust door control devices to compensation for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper finish, and provide final protection and maintain condition that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMOSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain door hardware and door hardware finishes.

3.8 DOOR HARDWARE SETS

HARDWARE SET: 01

DOOR NUMBER:
218

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	PANIC HARDWARE	9949-EO	626	VON
1	EA	ELEC PANIC HARDWARE	QEL-9949-L-NL-17-CON 24 VDC	626	VON
1	EA	RIM CYLINDER	1E72	626	BES
2	EA	SURFACE CLOSER	4040XP SHCUSH	689	LCN
2	EA	ARMOR PLATE	8400 48" X 1" LDW B-CS (PREP/NOTCH FOR HARDWARE AS REQUIRED)	630	IVE
1	SET	GASKETING	429AA-S	AA	ZER
1	EA	WEATHERSTRIPPING	8217SBK PSA	BK	ZER
2	EA	DOOR BOTTOM	365AA	AA	ZER
2	EA	DOOR SWEEP	8197AA	AA	ZER
2	EA	MEETING STILE	873AA	AA	ZER
1	EA	THRESHOLD	566A-223	A	ZER
4	EA	WIRE HARNESS	CON (VERIFY LENGTH REQUIRED)		SCH
2	EA	DOOR CONTACT	7764	628	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE
1			CARD READER - WORK OF DIVISION 28		

OPERATION: DOORS PROGRAMMED TO BE LOCKED/UNLOCKED DURING SCHEDULED HOURS. ENTRY BY VALID CARD READ WHEN LOCKED. FREE FOR IMMEDIATE EGRESS. DOOR CONTACT MONITORS OPEN/CLOSE POSITION OF DOORS. KEY SWITCH TO TURN OFF AUTO OPERATORS WITH KEY.

HARDWARE SET: 02

DOOR NUMBER:
208

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	9849-EO	626	VON
1	EA	PANIC HARDWARE	9849-NL	626	VON
1	EA	RIM CYLINDER	1E72	626	BES
2	EA	OH STOP & HOLDER	90H	630	GLY
2	EA	SURFACE CLOSER	4040XP LONG (TOP JAMB MOUNT)	689	LCN
2	EA	FLUSH CEILNG MTG PLT	4040XP-18G	689	LCN
2	EA	ARMOR PLATE	8400 48" X 1" LDW B-CS (PREP/NOTCH FOR HARDWARE AS REQUIRED)	630	IVE
1	SET	GASKETING	429AA-S	AA	ZER
1	EA	WEATHERSTRIPPING	8217SBK PSA	BK	ZER
2	EA	DOOR BOTTOM	365AA	AA	ZER
2	EA	DOOR SWEEP	8197AA	AA	ZER
2	EA	MEETING STILE	873AA	AA	ZER
1	EA	THRESHOLD	566A-223	A	ZER
2	EA	DOOR CONTACT	7764	628	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE

HARDWARE SET: 03

DOOR NUMBER:
218.1

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	9949-L-BE-06-LBL	626	VON
2	EA	SURFACE CLOSER	4040XP SHCUSH	689	LCN
2	EA	ARMOR PLATE	8400 48" X 1" LDW B-CS (PREP/NOTCH FOR HARDWARE AS REQUIRED)	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
2	EA	DOOR BOTTOM	355AA	AA	ZER
2	EA	MEETING STILE	873AA	AA	ZER

HARDWARE SET: 04

DOOR NUMBER:
217 219.1

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	REMOVABLE MULLION	KR4954	689	VON
2	EA	PANIC HARDWARE	98-EO	626	VON
1	EA	CYLINDER	1E74	626	BES
2	EA	SURFACE CLOSER	4040XP SHCUSH	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	SET	GASKETING	429AA-S	AA	ZER
1	EA	MULLION SEAL	8780NBK PSA	BK	ZER
1	SET	ASTRAGAL	8878AA-S	AA	ZER
2	EA	DOOR BOTTOM	365AA	AA	ZER
1	EA	MEETING STILE	383AA	AA	ZER
2	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	566A-223	A	ZER
2	EA	DOOR CONTACT	7764	628	SCE

HARDWARE SET: 05

DOOR NUMBER:
214

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	98-NL	626	VON
1	EA	RIM CYLINDER	1E72	626	BES
1	EA	SURFACE CLOSER	4040XP SHCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	SET	GASKETING	429AA-S	AA	ZER
1	EA	DOOR BOTTOM	365AA	AA	ZER
1	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	566A-223	A	ZER
1	EA	DOOR CONTACT	7764	628	SCE

HARDWARE SET: 06

DOOR NUMBER:
211

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	STOREROOM LOCK	9K37D 14D	626	BES
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	OH STOP & HOLDER	90H	630	GLY
2	EA	SURFACE CLOSER	4040XP LONG (TOP JAMB MOUNT)	689	LCN
2	EA	FLUSH CEILNG MTG PLT	4040XP-18G	689	LCN
2	EA	ARMOR PLATE	8400 48" X 1" LDW B-CS (PREP/NOTCH FOR HARDWARE AS REQUIRED)	630	IVE
1	SET	GASKETING	429AA-S	AA	ZER
2	EA	DOOR BOTTOM	361AA	AA	ZER
1	EA	MEETING STILE	383AA	AA	ZER
2	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	566A-223	A	ZER
2	EA	DOOR CONTACT	7764	628	SCE

HARDWARE SET: 07

DOOR NUMBER:
219.2 219

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	98-EO	626	VON
1	EA	SURFACE CLOSER	4040XP LONG (TOP JAMB MOUNT)	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 08

DOOR NUMBER:
207

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	98-NL	626	VON
1	EA	RIM CYLINDER	1E72	626	BES
1	EA	SURFACE CLOSER	4040XP SHCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 09

DOOR NUMBER:
207.1 208.1

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	98-EO	626	VON
1	EA	SURFACE CLOSER	4040XP SHCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 10

DOOR NUMBER:

201	201A	202	202A	203	203A
204	204A	205	205A	206	206A

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	STOREROOM LOCK	9K37D 14D	626	BES
1	EA	ELECTRIC STRIKE	6211 FSE CON 12/16/24/28 VAC/VDC	630	VON
1	EA	MAGNETIC LOCK	M450P 12/24 VDC	628	SCE
1	EA	SURFACE CLOSER	4040XP SHCUSH	689	LCN
1	EA	ARMOR PLATE	8400 48" X 1" LDW B-CS (PREP/NOTCH FOR HARDWARE AS REQUIRED)	630	IVE
1	EA	DOOR CONTACT	679-05	WHT	SCE
1	EA	PUSH BUTTON	CB401-AU (ONE PER ROOM)	630	SDC
1	EA	EMER RELEASE BUTTON	CB401-B	630	SDC
2	EA	OCC INDICATOR LIGHT	CM-AF550	630	CAM
1	EA	POWER SUPPLY	631RF UR2-4 (ONE PER ROOM)		SDC
1			CARD READER - WORK OF DIVISION 28		
3	EA	SILENCER	SR64	GRY	IVE

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. VALID CARD READ UNLOCKS DOOR, UNLESS OPPOSING INTERLOCK DOOR IS OPEN. OPENING OPPOSING DOORS LOCKS MAG LOCK ON THIS DOOR FROM BOTH SIDES UNTIL OPPOSING DOOR CLOSES. OPENING THIS DOOR LOCKS MAG LOCK AT OPPOSING INTERLOCK DOOR FROM BOTH SIDES UNTIL DOOR CLOSES. WHEN DOOR IS CLOSED PRESSING LOCK BUTTON LOCKS OUT CARD READER FOR PRIVACY AND ILLUMINATES INDICATOR LIGHT. LEAVING EITHER DOOR RESETS SYSTEM. EMERGENCY PUSH BUTTON UNLOCKS BOTH DOORS FOR EMERGENCY ACCESS. FREE EGRESS UNLESS OPPOSING INTERLOCK DOOR IS OPEN.
*COORDINATE INSTALLATION WITH SYSTEM INTEGRATOR. SYSTEM INTEGRATOR TO VERIFY OPERATION AND CONFIRM ALL COMPONENTS REQUIRED.

HARDWARE SET: 11

DOOR NUMBER:

201A.1	201B	202A.1	202B	203A.1	203B
204A.1	204B	205A.1	205B	206A.1	206B
216					

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	CONST LATCHING BOLT	FB51T	630	IVE
1	EA	PASSAGE SET	9K30N 14D	626	BES
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	SURFACE CLOSER	4040XP HEDA	689	LCN
2	EA	ARMOR PLATE	8400 48" X 1" LDW B-CS (PREP/NOTCH FOR HARDWARE AS REQUIRED)	630	IVE
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
2	SET	ASTRAGAL	8878AA-S	AA	ZER
2	EA	DOOR BOTTOM	355AA (CONFIRM COMPATIBILITY WITH FRP DOOR)	AA	ZER
2	EA	DOOR CONTACT	679-05	WHT	SCE

HARDWARE SET: 12

DOOR NUMBER:

217.2	220

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
2	EA	PUSH PLATE	8200 4" X 16"	630	IVE
2	EA	PULL PLATE	8302 10" 4" X 16"	630AM	IVE
1	EA	SURF. AUTO OPERATOR	9563 REG/STD HL/D MS AS REQ (120/240 VAC)	ANCLR	LCN
1	EA	SWITCH	8310-806R		LCN
2	EA	ACTUATOR, TOUCHLESS	8310-810S	630	LCN
2	EA	ARMOR PLATE	8400 48" X 1" LDW B-CS (PREP/NOTCH FOR HARDWARE AS REQUIRED)	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
2	SET	ASTRAGAL	8878AA-S	AA	ZER
2	EA	DOOR BOTTOM	355AA	AA	ZER

HARDWARE SET: 13

DOOR NUMBER:
209 212 214.1

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	PASSAGE SET	9K30N 14D	626	BES
1	EA	SURFACE CLOSER	4040XP H SRI	689	LCN
1	EA	ARMOR PLATE	8400 48" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 14

DOOR NUMBER:
210 213

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	PASSAGE SET	9K30N 14D	626	BES
1	EA	SURFACE CLOSER	4040XP SHCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE

HARDWARE SET: 15

DOOR NUMBER:
215

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	PRIVACY LOCK	L9040 17B 09-544 L283-722	626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

END OF SECTION
087111

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 08 80 00 - GLAZING

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes glazing for the following products:
   1. Storefront construction.
   2. Hollow metal door lites.

B. Related Sections: The following Sections contain requirements that relate to this Section:

   1. Section 08 41 13 "Aluminum-Framed Storefronts" for insulated glass in aluminum frames.
   2. Section 08 11 13 “Hollow Metal Doors and Frames” for insulated and non-insulated glass in hollow metal doors.

1.3 SUBMITTALS

A. Product data for each glass product and glazing material indicated.

B. Samples of manufacturer's standard sealant colors for selection by Architect.

C. Samples of glass to include tinted glass.

1.4 QUALITY ASSURANCE

A. Glazing Publications: Comply with "FGMA Glazing Manual" and "LSGA Design Guide," except where more stringent requirements are indicated.

B. Glazier Qualifications: Engage an experienced glazier who has completed glazing similar to that indicated for Project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials to comply with manufacturer's directions and as needed to prevent damage to glass and glazing materials.

1.6 WARRANTY

A. Manufacturer's Warranty on Insulating Glass: Submit written warranty signed by manufacturer of insulating glass agreeing to furnish replacements for insulating glass units that deteriorate as defined in "Definitions" article, f.o.b. point of manufacture, freight allowed Project site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, protecting, and maintaining practices contrary to glass manufacturer's published instructions.

1. Warranty Period: Manufacturer's standard but not less than 10 years after date of Substantial Completion.

2. PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, provide products of the following:

1. Ford Glass Division
2. Libby-Owens-Ford Co.
3. P.P.G. Industries, Inc.
4. Vitro

B. See Glass Schedule at the end of this section for specific glass types.

2.2 ELASTOMERIC GLAZING SEALANTS

A. General: Comply with glass manufacturer's recommendations.

B. Colors: As selected by Architect from manufacturer's standards.

C. Elastomeric Glazing Sealant Standard: ASTM C 920.

2.3 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with 100% solids content, nonstaining and nonmigrating, with or without spacer rod as recommended by tape and glass manufacturers, and complying with AAMA 800.

2.4 GLAZING GASKETS

A. Glazing Gaskets: Resilient polyvinylchloride or other material as required.

2.5 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers and Sealers: As recommended by sealant or gasket manufacturer.

B. Setting Blocks: Shore A durometer hardness of 85 plus or minus 5.

C. Spacers: Blocks or extrusions with a Shore A durometer hardness as required.

D. Edge Blocks: As needed to limit glass lateral movement (side-walking).

3. EXECUTION

3.1 EXAMINATION

A. Examine glass framing, with glazier present, for compliance with installation tolerances; minimum required face or edge clearances; and effective sealing between joints of glass-framing members.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings that are not firmly bonded to substrates.

3.3 GLAZING

A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass from edge damage during handling and installation. Use a rolling block in rotating glass to prevent damage to corners. Use suction cups to shift glass within openings; do not raise or drift glass with a pry bar. Rotate glass lites with flares or bevels on bottom horizontal edges.

C. Apply primers to joint surfaces where required for adhesion of sealants.

D. Install elastomeric setting blocks, sized and located to comply with glazing standard. Set blocks in thin course of sealant suitable for heel bead.

E. Provide spacers for glass sizes larger than 50 united inches. Provide 1/8 inch minimum bite and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

F. Provide edge blocking to comply with requirements of referenced publications.

3.4 PROTECTION AND CLEANING

A. Protect glass from breakage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction for build-up of alkali deposits or stains and remove as recommended by glass manufacturer.

C. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents and vandalism, during construction period.

D. Wash glass on both faces in each area of Project not more than 4 days prior to Substantial Completion. Wash glass as recommended by glass manufacturer.

3.5 GLASS SCHEDULE

A. CLEAR INSULATING FLOAT GLASS (EXTERIOR DOORS AND STOREFRONT)

1. Description: Type I, Class 1, Quality q3; Basis of Design – Vitro Optigray (#1); 90% Argon, 10% Air; Solarban 60 (#3). BOD to be provided or equal submitted and approved prior to bid submission.
2. Visible light 80%.
3. Low Emissivity Coating: Magnetically sputtered on third surface.
4. Thickness: 1/4" glass, 1/2" air space, 1" overall.
5. Tempered interior, heat-strengthened exterior.
6. U-value .29 winter / .27 summer
7. SHG .29 max.

B. CLEAR TEMPERED FLOAT GLASS (INTERIOR DOORS)

1. Type 1, Class 1 tempered.

END OF SECTION 08 80 00

SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - **GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

B. Related Requirements:

1. Section 05 40 00 "Cold-Formed Metal Framing".
2. Section 09 29 00 “Gypsum Board”.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 FRAMING SYSTEMS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.

C. Studs and Runners: ASTM C 645.

1. Steel Studs and Runners:

    a. Minimum Base-Metal Thickness, unless otherwise indicated:
        1) Framing behind standard panels: 0.0329" inches
        2) Framing behind impact resistant panels: 0.0329" inches
        3) Framing behind tile backer panels: 0.0329 inches
    b. Depth: 3-5/8 inches (92 mm) unless otherwise indicated.

D. Flat Strap and Backing Plate: Steel sheet for blocking.

1. Minimum Base Metal Thickness: 0.027 inches

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.3 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.

2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

END OF SECTION 09 22 16

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.

B. Related Requirements:

1. Section 05 40 00 “Cold-formed Metal Framing”
2. Section 09 22 16 "Non-Structural Metal Framing"

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. American Gypsum.
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC.
4. National Gypsum Company.
5. USG Corporation.
6. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch .
2. Long Edges: Tapered.
3. Provide moisture-resistive panels 4’ minimum horizontal and vertical at floor basin sink locations.
4. Type: manufacturer’s recommended type capable of spanning 24” between framing, single layer.

2.2 TILE BACKING PANELS

A. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C 1178, Type X, in maximum lengths available to minimize end-to-end butt joints, with manufacturer's standard square edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corporation; GlasRoc® 5/8" Type X Tile Backer.
b. Georgia-Pacific Gypsum LLC—DensShield® Fireguard Tile Backer.
c. USG—Durock™ Glass-Mat Tile Backerboard.
d. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2. Thickness: 5/8 inch .
3. Mold Resistance: ASTM C 1178, score of 10.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
2. Shapes:

    a. Cornerbead.
    b. LC-Bead: J-shaped; exposed long flange receives joint compound.
    c. L-Bead: L-shaped; exposed long flange receives joint compound.
    d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
    e. Expansion (control) joint – v-shape.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Fry Reglet Corp.
    b. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 Alloy 6063-T5.
3. Finish: Class I Clear Anodic Finish: AA-C12C22A3.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

D. Joint Compound for Tile Backing Panels:

1. Cementitious Backer Units: As recommended by backer unit manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 APPLYING TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.

B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

1. If control joints are not shown on the drawings they shall be located at a maximum of 30 feet on center.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.
2. LC-Bead: Use at exposed panel edges.
3. L-Bead: Use where indicated.
4. U-Bead: Use where indicated.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840 and Gypsum Association GA-214-10.

1. Level 1: Mechanical and electrical rooms, concealed areas, and where indicated.

2. Level 5: All other locations.

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 09 30 00 - TILE

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section Includes:
   1. Porcelain Ceramic Tile

B. Module Size: Actual tile size plus joint width indicated.

C. Face Size: Actual tile size, excluding spacer lugs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Selection: For tile, grout, and accessories involving color selection.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PRODUCTS

1.5 MANUFACTURERS

A. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.

   1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

1.6 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements.

1.7 TILE BACKING PANELS

Basis-of-Design Product—Fiberglass-Mat Faced Gypsum Backing Board: USG—Durock™ Glass-Mat Tile Backerboard. ASTM C 1178, Type X, in maximum lengths available to minimize end-to-end butt joints

1.8 ACCESSORIES

A. Metal Edge Accessories: For porcelain ceramic tile walls provide Schluter-Systems L.P. metal accessories (edge finishes) as noted below. Note that model numbers listed on drawings shall override if listed differently.

1.9 SETTING MATERIALS

1. Interior Tile—Typical (Thinset):

a. Bostik Findley—Big Tile and Stone™ (polymer modified large and heavy tile mortar).
b. LATICRETE International Inc—4-XLT.
c. MAPEI Corporation—Ultraflex™ LFT™ System.
d. MAPEI Corporation—Ultraflex RS.
e. TEC Specialty Products (H.B. Fuller)—Medium Bed mortar, #3N1® Performance Mortar.
f. Other equivalent products may be accepted if and as specifically approved by Architect by Addendum during bidding period.

1.10 GROUTING MATERIALS

A. Epoxy Grout: ANSI A118.3 .

1. Interior Walls & Floors:

a. Bostik Findley—Hydroment EzPoxy™ Grout and Mortar 100% Solids Epoxy.
b. CUSTOM Building Products—CEG-Lite 100% Solids Commercial Epoxy Grout.
c. Latiicrete—Latapoxy® 2000 IG Industrial 100% Solids Epoxy Grout
d. Latiicrete—SpectraLOCK® PRO Premium Sanded Grout.
e. MAPEI Corporation—Kerapoxy water cleanable 100% Solids Epoxy Grout.

f. TEC Specialty Products (H.B. Fuller)—AccuColor® EFX 100% Solids Epoxy Grout, #TA-440.
g. Color—As selected by Architect from manufacturer's standards or as listed in subparagraphs above.
h. Other equivalent products may be accepted if and as specifically approved by Architect by Addendum during bidding period.

1.11 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

2. EXECUTION

2.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

    a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

2.3 INSTALLATION, GENERAL

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
   1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
   2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
   3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
   1. Porcelain Tile: 1/4 inch (6.4 mm).

2.4 CRACK ISOLATION MEMBRANE INSTALLATION

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

2.5 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter:

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

END OF SECTION 09 30 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 09 67 33 – TROWEL-APPLIED RESINOUS FLOORING AND WALL COATING

1. PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Resinous flooring systems with high-build double-broadcast applied flooring system consisting of 100% solids epoxy binder, that consists of epoxy resin ad colored quartz aggregate with a high-solids, two-component 100% aliphatic urethane topcoat providing a slip-resistant surface on interior concrete floors.
2. Installer pre-approval required.

B. Related Requirements:

1. Section 03 30 00 “Cast-In-Place Concrete”.

1.3 PRE-INSTALLATION MEETINGS

A. Pre-Installation Conference: Conduct conferenced at Project Site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer’s technical data, material test reports, application instructions, chemical resistance, surface preparation, and application instructions.

B. Samples for Initial Selection: For each type of exposed finish and texture required.

C. Samples for Verification: For each resinous flooring system required, 12 inches (300-mm) square, applied to rigid backing by Installer for this Project.

1. Samples for review of color and texture.

D. Test Data: Provide a letter confirming that the concrete substrate meets all specified requirements including, not limited to product manufacturer specific requirements prior to commencing with floor finish installation. Include in letter, documentation of test results showing passing results.

1.5 INFORMATIONAL SUBMITTALS

A. Installer Qualifications:

1. Provide documentation of the requirements listed under Quality Assurance.
2. Applicator personnel shall be trained for application of specified materials.

a. Provide a list of employees trained for application of specified materials with product manufacturer's statement of qualification training for installation.

3. Provide a list of completed projects including project name and location, name of Architect, name of material manufacturer, and approximate quantity of materials applied.

1.6 MOCKUP

A. Provide 6"x18" mockups of three levels of texture for selection by Owner regarding finish and slip resistance. Levels of additive for mockup to be discussed with Owner and Architect and agreed to prior to mockup installation. Mockup location to occur in agreed location in pre-application meeting within space to receive sealed concrete per finish schedule (mechanical or electrical room).

1.7 CLOSEOUT SUBMITTALS

A. Maintenance data: For resinous flooring to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who employs only persons trained and approved by resinous flooring manufacturer for applying resinous flooring systems indicated.

1. Qualifications of installers for resinous flooring system shall not be less than seven (7) years of experience installing resinous flooring systems indicated. Resinous flooring installer shall be manufacturer approved and have performed at least ten similar installations. Resinous flooring installer shall have a minimum of 1,000,000 square feet of successful applications.
2. **Special Coatings System Installers must be pre-approved by the Architect**. Subject to the requirements of the specifications and approval of the manufacturer.

B. Pre-Application Meeting: Convene a pre-application meeting two (2) weeks before the start of application of floor coating system. Require attendance of parties directly affecting work of this section, including the Contractor, Architect, Applicator, Manufacturer's Representative, and Owner's Representative. Review the surface preparation, application, cleaning, protection, and coordination with other work.

C. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one source from a single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

1.11 WARRANTY

A. Manufacturer's written warranty against defects and wear for a period of five (5) years, including:

1. Delamination from substrate.
2. Loss of aggregate.
3. Degradation of finish.
4. Cracking and spalling
5. Water penetration.

2. PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Flammability: Self-extinguishing according to ASTM D 635.

2.2 MANUFACTURERS

A. Source Limitations:

1. Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer.
2. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials of type and from manufacturer recommended in writing by manufacturer of primary materials.

B. Requests for manufacturer substitutions prior to bidding will be reviewed and responded to in conformance with Division 1 requirements.

2.3 RESINOUS FLOORING

A. Resinous Flooring System: Abrasion-resistant, impact-resistant, and chemical-resistant, aggregate-filled, and resin-based monolithic floor surfacing designed to produce a seamless floor.

1. Basis-of-Design: Res-Tek—EPO-CF Double Broadcast colored Flake Resinous Flooring System.
2. Acceptable pre-approved Manufacturers—Towel-Applied Epoxy Resinous Flooring subject to compliance w/ Basis of Design product requirements include:

a. Tnemec Company - DecoTrowel
b. Desco Coatings, Inc—Cremona TG.
c. Stonhard®, Inc—StontecHRI with Stonseal SK6 Sealer/Top Coat.
d.

B. Dur-A-Flex-Hybri-Flex ACSika – Sikafloor DecoDur Flake FXColor(s):

1. RES-1 - Res-Tek—Pattern and Color: Full Flake per finish legend –Verify Color with Owner.
2. RES-2 - Res-Tek—Pattern and Color: Full Flake per finish legend —Verify Color with Owner.

C. System Characteristics:

1. Colored Flake with 100 percent solids according to ASTM D2369. Completely light stable over the normal life of the coating.

2. Wearing Surface: Medium Textured for slip resistance, match Architect's sample. Integral.
3. Cove Base: 6 inches high or as noted on drawings.
4. Overall System Thickness: 1/4-inch (6.4-mm) finish over sloped patching and fill material.

D. System Components: Manufacturer's standard components that are compatible with each other and as follows:

1. Primer: Type recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated.

   a. Basis of Design Product: Res-Tek EPO-203 High-Solids, Two-Component Moisture-Tolerant Modified Polyamine Epoxy.
   b. Formulation Description: 100 percent solids.

2. Floor Slope Build:

   a. Basis of Design Product: Modified Polyamine Epoxy. Mix with Portland cement, aggregate and dry silica as recommended by manufacturer.
   b. Formulation Description: 100 percent solids.

3. Body Coat—1st coat:

   a. Basis of Design Product: Res-Tek EPO-203 Pigmented — Modified Polyamine Epoxy.
   b. Formulation Description: 100 percent solids.

4. Broadcast—2 coats to refusal:

   a. Broadcast Colored Flake per manufacturer's written instructions.

5. Body Coat—2nd coat:

   a. Basis of Design Product: Res-Tek EPO-204—Modified Polyamine Epoxy.
   b. Formulation Description: 100 percent solids.

6. Grout Coat:

   a. Basis of Design Product: Res-Tek EPO-204—Epoxy. A Two-Component Modified Polyamine Epoxy.
   b. Dry Film Thickness: 14 - 18 DFT.

7. Topcoats: Sealing or finish coats.

a. Basis of Design Product: Res-Tek ISO-103—Epoxy. High Traffic Urethane Finish Coat.
b. Formulation Description: High Solids.
c. Type: Clear.
d. Finish: Satin/Low Sheen
e. Finish Texture: Manufacturer's standard
f. Dry Film Thickness: 2.0 – 3.0 DFT.

E. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated

1. Compressive Strength: 15,567 psi per ASTM C 579.
2. Tensile Strength: 2,200 psi per ASTM C 307.
3. Flexural Modulus of Elasticity: 4,550 psi per ASTM C 580.
4. Indentation: 2,000 psi according to MIL-D-3134.
5. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation per MIL-D-3134J.
6. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) per MIL-D-3134J.
7. Abrasion Resistance: 0.18gm maximum weight loss per ASTM D 4060.
8. Coefficient of Friction: 0.5 minimum according to STM D-2047.
9. Hardness: 85 - 90, Shore D per ASTM D 2240.

F. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected by the following:

1. 20% Hydrochloric Acid.
2. Mercurochrome.
3. Betadyne.
4. Urine.
5. Coffee.
6. Ethyl Alcohol.
7. Iodine.
8. 10% Lactic Acid.
9. Tea.
10. Mustard.

2.4 RESINOUS WALL COATING

A. Resinous Wall System:

1. Acceptable pre-approved Manufacturers—Resinous wall coating include:

a. Desco Coatings, Inc—Wallglass FX.
b. Stonhard®, Inc—Stoneglaze VSD.
c. Dur-A-Flex-Dur-A-Wall VC

d. Res-Tek-EPO 205 system

2.5 ACCESSORIES

A. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

B. Metal Edge Strips: Metal strips are to be provided by Resinous Flooring Installer and used at transitions between epoxy and adjacent floor finishes and two differing resinous flooring finishes as noted within and located on the finish plan.

3. PART 3 - EXECUTION

3.1 PREPARATION

A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Roughen concrete substrates as follows:

   a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
   b. Comply with ASTM C 811 requirements, unless manufacturer's written instructions are more stringent.
   c. Create a surface profile similar to ICRI-CSP5.

2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer’s written instructions.

   a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1,000 sq. ft. (1.36 kg of water/92.9 sq m) of slab area in 24 hours.
   b. Plastic Sheet Test: ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.

c. Relative Humidity Test: Use in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

4. Alkalinity and Adhesion Testing: Verify that concrete substrates have neutral pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Patching and Filling: Use patching and fill and build material to fill holes and depressions in substrates and to provide floor slopes where indicated according to manufacturer's written instructions to build floor surface to the specified slopes. Fill, sand or grind cured floor build to eliminate surface imperfections and trowel marks.

1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations.

D. Resinous Materials: Mix components and prepare according to resinous flooring manufacturer’s written instructions.

3.2 APPLICATION

A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated**.**

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.

a. Apply joint sealant to comply with manufacturer's written recommendations.

B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Floor Slope Build: Apply floor slope build product, where indicated, over primed substrate per manufacturer's recommendations.

D. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and top coating of cove base. Round internal and external corners.

E. Reinforcing Membrane: Apply reinforcing membrane to substrate cracks.

F. Double Broadcast Body Coats: Apply double broadcast body coats to refusal in thickness indicated for flooring system.

G. Topcoats: Apply topcoat(s) in number of coats indicated for flooring system and at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.

H. Add glass beads and/or top coats to achieve desired surface texture and uniformity.

3.3 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 09 67 33

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Modular carpet tile.

B. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

D. Samples for Verification: For each of the following products and for each color and texture required.

1. Carpet Tile.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Carpet and Rug Institute's CRI 104.

1.7 FIELD CONDITIONS

A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.

B. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

1.8 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

a. More than 10 percent edge raveling, snags, and runs.
b. Dimensional instability.
c. Excess static discharge.
d. Loss of tuft-bind strength.
e. Loss of face fiber.
f. Delamination.

3. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

A. Basis of Design: Shaw Industries, Welcome II 5T031, Charcoal 31549

B. Products to be considered as equal and alternate to Basis of Design if submitted and specifically approved by Architect by Addendum during the bidding period.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

C. Metal Edge/Transition Strips: Extruded aluminum with mill finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests per manufacturer recommendation prior to installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with the Carpet and Rug Institute's CRI 104, Section 13.7.

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13

SECTION 09 91 13 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on exterior substrates.

1. Steel and iron (including factory-primed).

B. Related Requirements:

1. Division 03 Section “Cast-In-Place” for concrete sealing requirements.
2. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
3. Section 05 12 00 "Structural Steel Framing" for shop priming of metal substrates.

4. 08 11 13 “Hollow Metal Doors and Frames” for factory-primed finishes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from the same product run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: Not less than 1 gal. of each material and color applied.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

A. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

B. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

C. Colors: Match existing Phase 1 building.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance. Ensure that edges, corners, crevices, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces. Recoat primed and sealed surfaces where evidence of unsealed areas in first coat appears.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Allow sufficient time betweens successive coats to permit proper drying.

F. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

G. Painting includes field painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

H. Painting is not required on pre-finished items, finished metal surfaces, concealed surfaces, operating parts and labels. Painting is required on all new items included in the work.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINT SCHEDULE

LOCATION	SHEEN	PAINT SYSTEM
Exterior Pre-Painted Steel	Semi-Gloss	EPS-1X
Exterior Painted Steel	Semi-Gloss	EPS-2X

3.6 EXTERIOR PAINTING SYSTEMS

A. System EPS-2X for application on Exterior Painted Steel Ferrous Metal:

1. Semi-Gloss Latex Finish: Apply two (2) coats over primer with total dry film thickness not less than 2.5 mils.
2. Acrylic, Rust-Inhibiting Primer: Quick-drying, rust-inhibiting primer for priming ferrous metal on the interior under waterborne semi-gloss enamels**:**

    a. DV: Diamond Prime Universal Primer.
    b. Moore: SuperSpec HP Acrylic Metal Primer #P04/KP04.
    c. P & L: Acrylic Waterborne Bonding Primer Z6650.
    d. PPG Paints: Breakthrough, #V70.
    e. SW: Pro-Cryl Universal Metal Primer, B66 W 310.

3. Exterior Acrylic Semi-Gloss Paint for use over a primer on exterior ferrous surfaces:

    a. DV: Vers-Acryl 222 Acrylic Maintenance Semi-Gloss.
    b. Moore: SuperSpec DTM Acrylic Semi-Gloss #P29/KP29.
    c. P & L: Acrylic Waterborne DTM Semi-Gloss Z6761 .
    d. PPG Paints: PittTech Plus Semi-Gloss DTM Industrial Enamel #90-1210.
    e. SW: DTM Acrylic Semi-Gloss, #B66-200 Series.

END OF SECTION 09 91 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on interior substrates.

1. Gypsum board.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in the manufacturer’s original, unopened packages and containers bearing manufacturer’s name and label.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Nonflat Paints and Coatings: 150 g/L.
2. Primers, Sealers, and Undercoaters: 200 g/L.

C. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
2. Restricted Components: Paints and coatings shall not contain any of the following:

a. Acrolein.
b. Acrylonitrile.
c. Antimony.
d. Benzene.
e. Butyl benzyl phthalate.
f. Cadmium.
g. Di (2-ethylhexyl) phthalate.
h. Di-n-butyl phthalate.
i. Di-n-octyl phthalate.

j. 1,2-dichlorobenzene.
k. Diethyl phthalate.
l. Dimethyl phthalate.
m. Ethylbenzene.
n. Formaldehyde.
o. Hexavalent chromium.
p. Isophorone.
q. Lead.
r. Mercury.
s. Methyl ethyl ketone.
t. Methyl isobutyl ketone.
u. Methylene chloride.
v. Naphthalene.
w. Toluene (methylbenzene)
x. 1,1,1-trichloroethane.
y. Vinyl chloride.

D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Colors: To be selected from manufacturer's standard range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Plaster Substrates: Verify that plaster is fully cured.

E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.

F. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

G. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

B. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

C. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable in writing to topcoat manufacturers.

B. Allow sufficient time between successive coats to permit proper drying.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

E. Provide “wet paint” signs to protect newly painted finishes.

3.5 INTERIOR PAINT SCHEDULE

LOCATION	SHEEN	PAINT SYSTEM
Interior Gypsum Drywall	Semi-Gloss	GDW-4I

3.6 INTERIOR PAINTING SYSTEMS

A. System GDW-4I for application on Interior Gypsum Drywall:

1. Semi-Gloss Latex Finish: 2 finish coats over primer.
2. Latex-Based Interior White Primer: Latex-based primer coating used on interior gypsum drywall under a flat latex paint.

a. Devoe: “WonderPure” Primer recommended for substrate listed.
b. DV: “Health-Kote” Low Odor Primer/Flat Finish, DF-1591.
c. Kwal: “Envirokote” Primer, 08300.
d. Moore: “Pristine ECO-Spec” Primer, 231.
e. P & L: Pro-Hide Gold Interior Low Odor Latex Primer, Z9165.
f. PPG Paints: “Pure Performance” Interior Latex Primer, 9-900 Series.
g. S-W: ProMar 200 Zero VOC Interior Latex Primer, B28 Series.
h. S-W: “Harmony” Interior Latex Primer, B11W900.

3. Semi-Gloss Latex Finish:

a.	Devoe:	“WonderPure” Low Odor Interior Latex Semi-Gloss recommended for substrate listed.
b.	DV:	“Health-Kote” Low Odor Interior Latex Semi-Gloss, DS-1591.
c.	Kwal:	Envirokote Semi Gloss, 3310.
d.	Moore:	Super Hide Zero Latex Semi-Gloss, 358.
e.	P & L:	Pro-Hide Gold Interior Low Odor Latex Semi-gloss, Z9300 Series.
f.	PPG Paints:	“Pure Performance” Latex Semi-Gloss Enamel, 9-500 Series.
g.	S-W:	ProMar 200 Zero VOC Semi-Gloss, B31 Series.
h.	S-W:	“Harmony” Interior Latex Semi-Gloss, B10 Series.

END OF SECTION 09 91 23

SECTION 09 96 00 – HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of high-performance coating systems on the following substrates:

1. Interior Substrates:

a. Concrete Masonry Units
b. Gypsum board.
c. Metal Doors and Frames.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, which match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: Not less than 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who employs only persons trained and approved by special coatings manufacturer for applying special coatings systems indicated.

1. Qualifications of installers for special coatings system shall not be less than five years of experience installing specified items. Special coatings installer shall be manufacturer approved and have performed at least ten similar installations.
2. Special Coatings System Installers must be pre-approved by the Architect. Subject to the requirements of the specifications and approval of the manufacturer, pre-approved installers are listed in paragraph 2.1 of this Section.

B. Single-Source Responsibility: Provide primers and undercoat material produced by the same manufacturer as the finish coats for each type of coating. Use only thinners recommended by the manufacturer and only within recommended limits.

C. Mock-ups: Apply mock-ups of each coating system indicated to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect or Owner will select one surface to represent surfaces and conditions for application of each coating system.

a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).

2. Apply mock-ups after permanent lighting and other environmental services have been activated.

3. Final approval of color selections will be based on mock-ups.

a. If preliminary color selections are not approved, apply additional mock-ups of additional colors selected by Architect at no added cost to Owner.

4. Approval of mock-ups does not constitute approval of deviations from the Contract Documents contained in mock-ups unless Architect or Owner specifically approves such deviations in writing.
5. Subject to compliance with requirements, approved mock-ups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 HIGH-PERFORMANCE COATINGS, GENERAL

A. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Products shall be of same manufacturer for each coat in a coating system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Masonry (Clay and CMUs): 12 percent.

2. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify compatibility with and suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

F. Notify the Architect of problems anticipated using the coatings specified over substrates primed by others.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

3.3 APPLICATION

A. Provide finish coats compatible with the primers used.

B. Apply high-performance coatings according to manufacturer's written instructions and recommendations:

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.

3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

    a. The term “exposed surfaces” includes areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.

4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

D. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

E. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

F. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Where sanding is required, according to the manufacturer’s directions, sand between applications to produce a smooth, even surface.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

E. Provide “Wet Paint” signs to protect newly coated finishes.

F. Refer to the drawings, room finish schedules and notes for paint requirements. Architect shall approve all “match adjacent surfaces” colors before painting begins.

3.5 HIGH-PERFORMANCE COATINGS, GENERAL

A. Material Compatibility.

1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. Provide products of same manufacturer for each coat in a coating system.

B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
2. Restricted Components: Paints and coatings shall not contain any of the following:

    a. Acrolein.
    b. Acrylonitrile.
    c. Antimony.
    d. Benzene.
    e. Butyl benzyl phthalate.
    f. Cadmium.
    g. Di (2-ethylhexyl) phthalate.
    h. Di-n-butyl phthalate.
    i. Di-n-octyl phthalate.
    j. 1,2-dichlorobenzene.
    k. Diethyl phthalate.
    l. Dimethyl phthalate.
    m. Ethylbenzene.
    n. Formaldehyde.
    o. Hexavalent chromium.
    p. Isophorone.
    q. Lead.
    r. Mercury.
    s. Methyl ethyl ketone.
    t. Methyl isobutyl ketone.
    u. Methylene chloride.
    v. Naphthalene.
    w. Toluene (methylbenzene).
    x. 1,1,1-trichloroethane.
    y. Vinyl chloride.

C. Colors: As selected by Architect from manufacturer's full range

D. HIGH-PERFORMANCE COATINGS SCHEDULE

LOCATION	SHEEN	COATINGS SYSTEM
Interior Ferrous Metal	Semi-Gloss	IFM-1X
Interior Ferrous Metal	Semi-Gloss	IFM-6X
Interior Gypsum Drywall (Epoxy)	Semi-Gloss	GDW-51
Interior CMU/Concrete (Epoxy)	Gloss Epoxy	CMU-31 (PTE)

3.6 INTERIOR HIGH-PERFORMANCE COATING SYSTEMS

A. System IFM-1X for application on Interior Ferrous Metal:

1. Semi-Gloss Acrylic Polymer: Two (2) finish coats over an epoxy primer. (Primer to be applied by metal fabricator in shop.) / Two (2) finish coats over an epoxy primer used on interior ferrous metal surfaces shall be full-prime coated, Typical and applied per manufacturer's written specifications.
2. Touch-Up Metal Primer: Epoxy primer used on interior ferrous metal surfaces shall be touch-up primed as required if pre-primed steel is used, Typical and applied per manufacturer's written specifications.

    a. Thickness: 2.5 – 3.5 mils.
    a. PPG Paints: Amerlock, 2/400.
    b. SW: Macropoxy 646 Fast Cure Epoxy.
    c. Tnemec: Epoxoline, Series 66.
    d. Or equal, if and as specifically approved by Architect by Addendum during bidding period.

3. Metal Primer: Epoxy primer used on interior ferrous metal surfaces shall be full-prime coated, Typical and applied per manufacturer's written specifications.

    a. Thickness: 2.5 – 3.5 mils.
    b. PPG Paints: TBD.
    c. SW: TBD.
    d. Tnemec: TBD.
    e. Or equal, if and as specifically approved by Architect by Addendum during bidding period.

4. Thermoset Semi-Gloss Fluoro-Polymer: Opaque coat for use over primed, ferrous metal surfaces: Custom color to match existing Phase 1 building.

    a. Thickness: 3 – 4 mils.
    b. PPG Paints: Coraflon ADS (solid color).
    c. SW: Shercryl HPA.
    d. Tnemec: HDP Acrylic Polymer, Series 1029.

e. Or equal, if and as specifically approved by Architect by Addendum during bidding period.

B. System GDW-51 for application on Interior Gypsum Drywall:

1. Eggshell / Semi-Gloss Latex Epoxy Finish: Two (2) finish coats over primer.
2. Latex-Based Interior White Primer: Latex-based primer coating used on interior gypsum drywall under an epoxy finish**:**

a. PPG Paints: "Pure Performance" Interior Latex Primer, 9-900 Series.
b. SW: "Harmony" Interior Latex Primer, B11W900, applied at 4 mils wet, 1.3 mils dry per coat.
c. Or equal, if and as specifically approved by Architect by Addendum during bidding period.

3. Semi-Gloss Latex Epoxy Finish: Custom colors toto match exiting Phase 1 building:

a. PPG Paints: Pitt-Glaze WB1 Water Based Pre-Catalyzed epoxy. (Eggshell finish) 16-310. Applied at 1.5 DFT.
b. PPG Paints: Pitt-Glaze WB 1 Water Based Pre-Catalyzed Epoxy. (Semi-Gloss finish) 16-510. Applied at 1.5 DFT.
c. SW: Pro Industrial™ Water-Based Pre-Catalyzed Epoxy (Eggshell finish), K45 Series, applied at 1.5 mils dry per coat.
d. SW: Pro Industrial™ Water-Based Catalyzed Epoxy (Semi-Gloss finish), B70W211 / B60V25, applied at 2.5 – 3 mils dry per coat.
e. Or equal, if and as specifically approved by Architect by Addendum during bidding period.

E. System CMU-31 for application on Interior CMU:

1. Low Odor Water-based Semi-Gloss Pre-Catalyzed Epoxy Finish: Two (2) coats over filled surface with total dry film thickness not less than 3.5 mils excluding filler coat.
2. High Performance Latex Block Filler: Heavy Duty latex block filler used for filling open textured interior concrete masonry block before application of top coats:

a. DV: DiaPro Acrylic Block Filler.
b. P & L: Krylon Industrial Heavy Duty Block Filler K-Z8465.
c. PPG Paints: SPEEDHIDE® Hi-Fill Interior/Exterior Latex Block Filler. Apply at a DFT of not less than @ 8.0 mils DFT.
d. S-W: Pro Industrial™ Heavy Duty Block Filler, B42W46. Apply at a DFT of not less than @ 8.0 mils DFT.

3. Water-based Semi-Gloss Pre-Catalyzed Epoxy: Two (2) coats of semi-gloss pre-catalyzed epoxy for use over a primer on concrete and masonry.

   a. DV: Eas-E-Poxy Pre-Catalyzed Waterborne Semi-Gloss Epoxy, ME-0574 / ME-1575 / ME-1573, applied at 2- 3 mils dry per coat.
   b. P & L: Krylon Industrial Precat Epoxy Acrylic Semi-Gloss K-Z7200 Series applied at 1.5 mils dry per coat.
   c. PPG Paints: PITT-GLAZE® WB1 Interior Semi-Gloss Pre-Catalyzed Water-Borne Acrylic Epoxy, applied at 1.5 mils dry per coat.
   d. S-W: Pro Industrial™ Water-Based Pre-Catalyzed Epoxy, K46 Series, applied at 1.5 mils dry per coat.

END OF SECTION 09 96 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 10 26 00 - WALL PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wall guards.
2. Corner guards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For each type of wall protection showing locations and extent.

1. Include plans, elevations, sections, and attachment details.

C. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:

1. Wall Guards: 6 inches long. Include examples of corners.

2. Corner Guard: 6 inches.

1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of wall protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain wall- and door-protection products of each type from single source from single manufacturer.

2.2 WALL GUARDS

A. Crash Rail: Heavy-duty assembly consisting of continuous stainless-steel bar designed to withstand impacts.

1. Inpro 52SS 2” 304 stainless steel satin finish wall guard with rounded corners (match guard in exiting facility).

2. Products to be considered as equal and alternate to Basis of Design if submitted and specifically approved by Architect by Addendum during the bidding period.

2.3 CORNER GUARDS

A. Surface-Mounted, Stainless Steel Corner Guards

1. Size: 2” legs, 42” length.

2. Installed with double-sided adhesive tape or adhesive sealant per manufacturer recommendation. Provide clear silicone sealant at gaps between walls.

2.4 CLEANING

A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 10 26 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 10 28 00 – TOILET ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Surface-Mounted Paper Towel Dispenser.
2. Surface-Mounted Soap Dispenser.
3. Surface-Mounted Toilet Tissue Dispenser.
4. Framed Mirror.
5. Grab Bar: Satin-Finish Stainless Steel, 1-1/2” (38 mm) diameter.
6. Stainless Steel Shower Curtain Rod.
7. Folding Shower Seat.
8. Towel Hook.
9. Underlavatory Guards.
10. Mop and Broom Holder (Custodial Accessories).

B. Related Requirements:

1.3 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the following.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Include electrical characteristics.
4. Features that will be included for Project.
5. Manufacturer's warranty.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

1.6 WARRANTY

B. Manufacturer’s Standard Warranty: Manufacturer’s standard form in which manufacturer agrees to repair, restore, or replace defective automated hand dryer components and labor within specified warranty period.

1. Warranty Period: One (1) year limited for labor and five (5) years for parts.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.

B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.

C. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.

D. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.

E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

H. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 STAINLESS STEEL SURFACE-MOUNTED TOILET TISSUE DISPENSER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Bobrick Washroom Equipment, Inc.
2. Bradley Corporation
3. Foundations Worldwide, Inc.
4. ASI
5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2.4 WALL-MOUNTED SOAP DISPENSER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bobrick Washroom Equipment, Inc.
2. Bradley Corporation
3. Foundations Worldwide, Inc.
4. ASI
5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2.5 FRAMED MIRROR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bobrick Washroom Equipment, Inc.
2. Bradley Corporation

3. Foundations Worldwide, Inc.
4. ASI
5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Stainless Steel 304 framed mirror installed with concealed hanging brackets; 18” x 36”.

2.6 GRAB BARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bobrick Washroom Equipment, Inc.
2. Bradley Corporation
3. Foundations Worldwide, Inc.
4. ASI
5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Stainless Steel, 1-1/2” (38 mm) diameter Grab Bar with 2” Snap End Flange..

1. 18-gauge, 1-1/2” (38 mm) diameter grab bar. Clearance between the grab bar and wall shall be 1-1/2” (38 mm). Concealed mounting flanges shall be 1/8” (3 mm) thick stainless steel plate, 2” x 3-1/8” (50 x 80 mm), and equipped with two screw holes for attachment to wall. Flange covers shall be 22 gauge (0.8 mm), 3-1/4” (85 mm) diameter x 1/2” (13 mm) deep, and shall snap over mounting flange to conceal mounting screws and/or WingIt fasteners. Ends of grab bar shall pass through concealed mounting flanges and be heliarc welded to form one structural unit. Grab bar shall comply with barrier-free accessibility guidelines (including ADAAG in the U.S.A.) for structural strength. Finish: Satin-Finish Type #304 Stainless Steel.

2.7 STAINLESS STEEL SHOWER CURTAIN ROD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Bobrick Washroom Equipment, Inc.
2. Bradley Corporation
3. Foundations Worldwide, Inc.
4. ASI
5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

C. Shower Curtain Rod: Satin-Finish Stainless Steel, 1” diameter rod.

2.8 FOLDING SHOWER SEAT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bobrick Washroom Equipment, Inc.
2. Bradley Corporation
3. Foundations Worldwide, Inc.
4. ASI
5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Folding Shower Seat - 20-gauge, 1” (25 mm) diameter rod. ADA Barrier-Free, 1/2” thick, durable, water-resistant phenolic seat, reversible for left or right-hand installation. Dimensions: 33” W, extends 22-15/16” D from wall. Finish: Ivory-colored, 1/2” thick phenolic.

2.9 TOWEL HOOK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Bobrick Washroom Equipment, Inc.
2. Bradley Corporation
3. Foundations Worldwide, Inc.
4. ASI
5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2.10 UNDERLAVATORY GUARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Plumberex Specialty Products, Inc.
2. Truebro by IPS Corporation.

3. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

C. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

2.11 MOP AND BROOM HOLDER (CUSTODIAL ACCESSORIES)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
3. Bobrick Washroom Equipment, Inc.
4. Bradley Corporation.
5. ASI
6. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

C. Mop and Broom Holder:

1. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
2. Length: 36 inches (914 mm).
3. Hooks: Three.
4. Mop/Broom Holders
5. Material and Finish: Stainless steel, No. 4 finish (satin).

2.12 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf , when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 10 28 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 10 44 13 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for the following:

a. Portable fire extinguishers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.

B. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate sizes and locations of fire-protection cabinets with wall depths.

1.6 SEQUENCING

A. Apply decals on field-painted fire-protection cabinets after painting is complete.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

2.2 FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for standard 10 lb fire extinguisher.

1. Products: Subject to compliance with requirements, provide one of the following:

a. JL Industries, Inc.; a division of the Activar Construction Products Group.
b. Larsens Manufacturing Company.
c. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Cabinet Material: Cold-rolled steel sheet.

C. Recessed Cabinet:

1. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
a. Coordinate with all wall types where cabinets are to be installed and note on Shop Drawings for Architects review.

D. Cabinet Trim Material: Same material and finish as door.

E. Door Material: Steel sheet.

F. Door Style: Vertical duo panel with frame.

G. Door Glazing: Tempered float glass (clear).

H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

I. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

2.3 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.
3. Prepare doors and frames to receive locks.
4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
2. Fabricate door frames of one-piece construction with edges flanged.
3. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

END OF SECTION 10 44 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 11 53 19 – DRY HEAT STERILIZER

1.0 GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 01 specifications Sections, apply to this section.

1.2 ACTION SUBMITTALS

Product data with manufacturer's qualified data for the unit including required utility services.
Shop drawings with specifics including but not limited to plans, elevations, sections, details that will assist with verification of chamber size, chamber access size, overall unit size with required rough openings and clearances, utility input locations.

2.0 EQUIPMENT DESCRIPTION / SUMMARY

Unit shall be a truck-in style, dry heat sterilizer to be used in the sterilization of poultry cages, various items designed to be sterilized at 285°F/140°C or better.
Proposed sterilizer shall be rated as a NFPA 86 Class "B" dry heat sterilizer.
Unit shall be a truck-in style, dry heat sterilizer to be used in the sterilization of poultry cages, various items designed to be sterilized at 285°F/140°C or better.
Proposed sterilizer shall be rated as a NFPA 86 Class "B" dry heat sterilizer.
The dry heat sterilizer shall be designed to accommodate cages/racks which are 38"W x 64"L x 74"H and 47"W* x 84.5"L x 86"H.
At a minimum, the interior chamber of the sterilizer shall be a minimum of 52"W x 86"L x 88X"H.
The exterior dimensions of the dry heat sterilizer shall not exceed 115"W x 95"L x 106"H.

3.0 DRY HEAT STERILIZER CONSTRUCTION

3.1 CHAMBER CONSTRUCTION

The dry heat sterilizer shall be constructed in modules, sized for ease of rigging and assembly without modification of the existing facility, from a welded heavy-duty steel frame that supports the interior stainless steel chamber. The exterior shall be constructed from stainless steel sheet metal. All interconnecting struts shall be non-continuous from inner to outer walls, thus keeping the exterior as cool as possible. A full 4" of insulation shall surround the work chamber on all sides, with the exception of the floor, which shall be 3/16" stainless plate. Locating pins integral to the frame must be used to align the modules during assembly and have interior flanges to bolt them together for perfectly aligned seams.

3.1.1 CHAMBER SIDE RAILS

Internal side rails shall be supplied and located down the length of the work chamber. These side rails shall be located at a height of 36" up from the chamber floor. The internal side rails shall

prevent the trucks from coming in contact with the side air duct walls in each work chamber. Chamber rail construction shall be designed for ease of cleaning and toolless removal.

3.1.2 FULLY WELDED LINER (BACK SIDE, SQUARE CORNERS)
The interior of the sterilizer shall be fabricated with 304L stainless steel with a 2B finish. All welds shall be ground and polished to match this finish. The dry heat sterilizer's stainless steel liner shall be continuously welded thus creating an impervious barrier between the process chamber and the insulation material and preventing any contamination from entering the chamber from that source.

3.1.3 FLOOR
The dry heat sterilizer shall contain a 3/16" thick plate floor. The front edges of the plate shall be beveled to give a loading truck a smooth transition into and out of the dry heat sterilizer.
The facility floor will be rated withstand to the operating temperature.

3.1.4 EXTERIOR FINISH
The exterior of the sterilizer shall be fabricated with 304 stainless steel with a #4 finish. All welds shall be ground and polished to match this finish. The following components shall be a 2B finish with welds chemically passivated: filter boxes, junction boxes, motor/blower mounts and pneumatic boxes.
The following components shall be a mill finish with welds mechanically passivated:
Exterior tubular stands and interior tubular guide rails.

3.2 DOOR
One individual door, one left hand hinged on the load end and one right hand hinged on the unload end, shall be fitted to the unit. The door close against the sterilizer cabinet over a silicone "P" gasket. Door shall be held closed by a dual cam-action bar latch and hung with a pair of stainless steel machined hinges. Each bar latch shall be supplied with an inside release handle. The bottom bar latch shall be side latching so no truck obstructions are located on the plate floor.

3.2.1 DOOR SWITCHES
Door switches shall be installed on the dry heat sterilizer to de-energize the heating and circulation systems when the dry heat sterilizer door is opened. This is to minimize hot air from being expelled from the dry heat sterilizer should the doors be opened during the heating cycle.

3.2.2 DOOR LOCK OPERATION
Each end door will be equipped with an automatic lock that will function in accordance with operational modes. Pneumatic interlocks will control the door lock sequence in this manner:
When the unload door is open, the load side door is locked;
When the load side door is open, the unload side door is locked
When the cycle is engaged, all doors are locked;

3.2.3 INTERIOR DOOR LOCK OVERRIDE
Inside the sterilizer, located along a duct wall in the work chamber, shall be door lock over-ride cables. When pulled, the cable shall activate the interior door override. This shall shut down the sterilizer and unlock the doors. The Safety Reset Button must be pushed to reset the PLC logic. Junction boxes to be mounted on the top of the unit.

3.2.4 WINDOW, DOOR
A viewing window shall be mounted in the face of the door. The viewing area shall be approximately 10" wide x 15.50" high with a 6-pane glass window. Each window shall be supplied with a window guard located above and below to protect the windows from accidental contact.

3.3 STAINLESS STEEL TRIM PANELS SEAL
Trim panels of 18 ga stainless steel matched to the exterior of the sterilizer shall be fitted to cover the area between the wall opening and the unit so that a flush appearance is achieved. The trim panels are held in place by magnets on the back of the panel to simplify the installation.

3.4 MODULAR/SPLIT CONSTRUCTION
The unit shall be built in sections to accommodate move in restrictions such as elevators, hallways, doorways and the like. The joining flanges shall be interior flange design. No joining hardware is to be mounted on the outside of the unit. Sections shall contain tapered alignment pins for ease of reassembly where possible.

4.0 PROCESS AIR CIRCULATION (HORIZONTAL)

To ensure uniform heat distribution throughout the oven chamber and optimize efficiency, a high volume, horizontal airflow system is installed in the unit. A large fan located in a plenum chamber on the r side of the sterilizer, directs air to a circulation duct up across a top mounted duct running to the opposite side of the unit. The air enters the work space through a semi-pierced wall, flows horizontally across the product, from the one side to the other side, and exits the work space through a semi-pierced wall on the other side, and is directed back to the fan for reheating and recirculation.

Note: Output of each circulation motor will be controlled by Variable Frequency Drives to allow for correct tuning of the oven system. Circulation systems are mounted on the right side of the unit.

5.0 AIR HEATING SYSTEM

Seamless-tubular incoloy type heaters shall be used as the heat source. The heaters are suspended in the plenum, adjacent to, but separate from the process chamber, so that work in progress and operators are protected. Terminal ends are inserted through the walls of the dry heat sterilizer and use sufficient dead zones so that heat is not generated beyond the plenum. All heaters are wired with double nut connections. The heaters shall be positioned between the circ. return duct and the circ. fan to ensure the maximum utilization of the electric heaters and the re-circulation of conditioned air.

5.1 FILTRATION

1. Intake Air Pre-filter
   Air shall be pre-filtered through 25-40% roughing filter, 24” x 24” x 2” thick

2. Exhaust Air Pre-filter
   Air shall be pre-filtered through a 25-40% roughing filter, 24” x 24” x 2” thick

3. Air Intake HEPA Filter

A 24" x 24" x 5-7/8" HEPA filter, rated at 99.97% efficient at particles 0.3 microns or larger, shall be installed in a stainless steel housing on the incoming airflow side of the conditioning path. Challenge ports are provided for the verification of filter integrity. Access panels in the filter housing are secured with acorn nuts on 3" centers.

4. Air Exhaust HEPA Filter

A 24" x 24" x 5-7/8" HEPA filter, rated at 99.97% efficient at particles 0.3 microns or larger, shall be fitted to the exhaust path to protect the chamber from particulate backflow. Challenge ports are provided for the verification of filter integrity. Access panels in the filter housing are secured with acorn nuts on 3" centers.

5. Forced Exhaust

A 1100 SCFM exhaust blower that shall operate at minimum SCFM during the cycle or 1100 SCFM during cooling shall be installed to the dry heat sterilizer's air exhaust system and be initiated by an output from the programmable temperature controller to provide for moisture removal during the sterilization period, and a cooling capacity at the end of the temperature soak cycle. The blower shall be 2-speed, with a lower rpm during the ramp and soak period and a higher speed during the cooling period. A 10" O.D. exhaust collar shall be supplied for attaching customer's exhaust connection.

6.0 CONTROLS AND INSTRUMENTATION

6.1 CONTROL CONSOLE

The main operating electrical components for the sterilizer are housed in a single free-standing remote control console and shall house the Micro850 PLC and other electrical components. Circuit wiring is complete, including a step-down transformer to provide the control circuits with 110-volt power. Wiring in the control console terminates in a suitable block for connection to the customer's power supply. The control console and control boxes shall be labelled as NEMA 1 but designed and built to NEMA 12 standards in order to comply with UL508A regulations.

1. U.L. Label

The control console and the control box shall be designed and built to comply with all current and pertinent UL508A directives and labelled. All control boxes shall be rated at NEMA 1, built to NEMA 12 design.

2. E-Stop

The control console shall include an E-Stop. When pressed, the sterilizer heat, circulation and exhaust fans shall stop and the load end doors shall unlock.

3. Controls Protection Rail

Stand-off rails shall be included on the face of the control console and HMI box to protect the face of the electrical controls from accidental damage from being hit by carts and operators. The bumper rails shall be a round design without sharp edges for easy cleaning and located above and below the controls on the face of the console.

6.2 DISCONNECT SWITCH
A fused power disconnect switch shall be installed on the main control console for safe maintenance of the sterilizer. The disconnect switch assures that the panel power is de-energized before the access door can be opened.

6.3 OPERATOR INTERFACE TERMINALS, 10" Display
One Operator interface terminal shall be supplied with this unit and located in the load end main control console. At a minimum, it shall feature:

10 inch diagonal (800 x 480) color TFT LCD and an analog-resistive touchscreen
Serial, Ethernet communications, and USB
Expandable memory for recipe and data log storage
Support monitoring from a personal computer (PC) with free VNC Client software
Data logging in Excel®-compatible comma separated value (.csv) files
Recipe management
128MB Memory
Provides audible alarms and key chirp
Flexible 4 level password security
UL®, NEMA 4, CE, RoHS rated

6.4 PLC
An Allen Bradley Micro850 PLC with on board Ethernet communications must be supplied to provide all control and functional logic of the sterilizer.

6.5 HIGH LIMIT THERMOSTAT
A separate, independent high limit thermostat shall be provided to de-energize the heating system should the process temperature reach the customer's preset limit. The high limit control must be manually reset to reactivate heating.

6.6 AIRFLOW SWITCHES
Pressure differential switches shall be installed and located in the air stream of the circulation and forced exhaust systems. Upon failure of either system, the airflow switch shall de-energize the heater circuit.

6.7 SEPARATE MAIN POWER RELAY
This relay is in addition to the normal relays serving the heater circuits. It shall be wired into the control circuit so that the high limit thermostat activates it. Should the main relays become mechanically frozen, as a result of extended use, this "back up" relay is deactivated, and the heat system shall be de-energized.

6.8 SCR
The sterilizer shall use SCR power controls installed to proportion power to the heaters only as necessary to maintain set-point temperature. This minimizes swings in set-point temperature, provides good temperature uniformity within the chamber, conserves energy and provides longer heater life.

6.9 PANEL MOUNT THERMAL PRINTER, EVENT LOGGER

A thermal panel mount 2" printer shall be included. It shall feature easy paper loading, incorporated paper cutter, end of roll signal, USB and RS232 connections. A NEMA 4 rated enclosure shall be supplied, mounted to the face of the control console.

6.10 COMMUNICATIONS INTERFACE MODULE

A Communications Interface module may be provided on the control panel. It shall include an Ethernet Port and a 120 VAC outlet for the connection of an external PC to perform software maintenance. A USB port shall also be provided.

6.11 AUDIBLE ALARM

An audible alarm with manual silencer shall be provided. Alarms, at a minimum, shall indicate over-temperature alarm, circ. and exhaust low airflow alarm, temperature deviation alarm, and filter alarm.

6.12 DRY CONTACTS FOR BMS INTEGRATION

The sterilizer shall be provided with two dry contacts. One shall signal the building management system (BMS) when the sterilizer is in cycle at low exhaust flow. The second dry contact shall signal the BMS when the sterilizer is in cooling at high exhaust flow.

6.13 HMI CONTROL BOXES (Locations at load/unload end, remote in wall panel)

Control boxes shall house an Operator Interface touchscreen terminal.

7.0 LOADING TRUCKS/TROLLEYS

Not used.

8.0 TESTING AND ACCEPTANCE

The factory testing shall include at least two tests: one empty chamber uniformity mapping, and one full chamber uniformity mapping and sterilization test. (Customer may supply a full complement of trucks and cages or the seller shall include these items for testing).
Factory standard testing and standard operating procedure documents shall be provided for review along with the approval drawings. SOP's to be included are, at a minimum, sterilizer functional testing SOP, chamber uniformity testing and calibration SOP, HEPA filter testing SOP, temperature controller and high limit calibration SOP and full load testing SOP.
Testing shall be performed using calibrated NIST traceable data recording equipment. The documentation of calibration shall be submitted to the client along with the test data.

8.1 TEMPERATURE UNIFORMITY

The sterilizer shall be equipped to maintain a temperature uniformity of ± 5ºF, at a test temperature of 300ºF. Test temperature readings are taken within a volume of space not exceeding 80% of each empty work chamber or closer than 3" from any of the six interior surfaces of each work chamber. At a minimum, a 12-point uniformity test shall be performed with a soak length of 60 minutes.

9.0 PRE-SHIPMENT EVALUATION WITNESS TEST

All equipment shall be built to the referenced specification and subject to the standard seller's test protocols pertinent to the specific equipment design. Additional test protocols maybe completed if agreed to prior to the equipment purchase. Clients shall be welcome to visit the factory *by arrangement* prior to shipment of their equipment in order to carry out a Pre-Shipment Evaluation Witness Test. As a minimum, this evaluation shall consist of the following.

- Dimensional review and quality check of system.
- Review of completed test data.
- Controls overview and interface.
- Functional review: Cycle operated either through the equipment design extremes or through the clients agreed to cycle parameters. Cycle operation is performed with a loaded chamber, including temperature mapping of the customer's load.

10.0 INSTALLATION

Seller shall send a factory trained technician(s) to manage and supervise the rigging and installation of the dry heat sterilizer. The installation shall be performed using a local rigger, at the direction and supervision of the seller's technician. The cost of the rigger shall be included in seller's proposal.

10.1 START-UP and TRAINING
Seller shall send a factory trained test technician to perform the start-up of the sterilizer. Training on the control system, maintenance, and overall features of the unit shall be provided. The startup shall follow manufacturer's standard SOP for startup and standard agenda for the user training.

10.2 POST INSTALLATION VALIDATION
Seller shall send a trained test technician to perform a Post Installation Validation on this unit. The scope of work shall consist of commissioning the sterilizer and the execution of the system's validation protocols as they were when the unit was tested at our facility before being shipped. A minimum of 3 different cycle types shall be developed and validated as part of the proposal. The installation shall follow manufacturer's SOP for cycle validation and be available for review prior to bid award. A written validation report showing the efficacy as challenged with a minimum of (20) 10-6 biological indicators for each cycle shall be provided to users at the end of testing.

10.3 INSTALLATION, START UP, TRAINING AND VALIDATION DOCUMENTATION
As part of the approval drawing process, seller shall provide copies of their standard operating procedures for the installation, start up, user training and post installation validation for review.

11.0 WARRANTY

At a minimum, a comprehensive two-year parts and labor warranty shall be included. The date of the warranty shall start at the date of substantial completion of the project.

12.0 MAINTENANCE AND OPERATING DOCUMENTS

Seller shall supply 1 set of operational and maintenance manuals on thumb-drive. It shall be complete with lubrication specifications, routine maintenance, parts lists, wiring, and mechanical drawings.

13.0 UTILITIES

1. V: 480V/240 or 208V / 3Ø / 60Hz / 176 FLA
2. CA: 2-5 CFM, 80-120psig
3. EXH: 10" OD, minimal SCFM during the cycle, 1100 SCFM during cooling. Up to 285°F

14.0 QUALIFICATIONS

14.1 MANUFACTURER'S QUALIFICATIONS
Vendor shall have been in the business of providing NFPA 86 rated dry heat sterilizers, dry heat sterilizers and related equipment for at least 10 years. In addition, vendor shall have direct laboratory animal industry experience with more than 7 years' experience and more than one dozen successful dry heat sterilizer installations specifically in cage sterilization applications in vivariums. All bidders must provide a list of at least 5 successful installations completed in the last five years. Manufacturers shall have established organizations and production facilities including all tools, equipment and special machinery necessary for specializing in the fabrication and installation of dry heat sterilizers, with skilled personnel, factory trained workmen and an experienced engineering department.

14.2: INSTALLER QUALIFICATIONS
Installer of dry heat sterilizers shall have an established organization including all tools, equipment and special machinery necessary for specializing in the installation, start up and validation of this equipment. Personnel shall have the demonstrated knowledge, ability and the capability to install the specified equipment of the required quality and capacity to complete an installation of this size and type within the required time limits. The firm specializing in installation of products specified shall have a minimum five years' experience and authorized by manufacturer to install product.
Manufacturer to provide installation standard operating procedure (SOP) documents for review along with the approval drawings. SOP's for the installation and validation to be included are, at a minimum, sterilizer field commissioning testing SOP, chamber uniformity testing SOP and cycle validation SOP.
Upon request, installer shall provide five references of similar installations.

15.0 MANUFACTURER

Products, which comply with this specification section as judged and approved by the Owner or Owner's Architect, may be provided by the following manufacturers. All dry heat sterilizers specified in this section shall be provided by a single manufacturer.

SECTION 11 53 20 – STEAM HEAT STERILIZER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Laboratory sterilization (autoclaves) equipment.

1.2 REFERENCES

A. All engineering, manufacturing, rating, and testing shall conform, when applicable, to the latest edition of the following codes, standards, and specifications in effect at the time of order placement:

1. ASME American Society of Mechanical Engineer.
2. AAMI Association for the Advancement of Medical
3. CGMP Current Good Manufacturing Practices
4. ANSI American National Standards Institute
5. OSHA Occupational Safety and Health Administration
6. NEMA National Electrical Manufacturers Association
7. NEC National Electric Code
8. MSS Manufacturer's Standardization society (SP-6)
9. FPA National Fire Protection Association
10. NPC National Plumbing Code
11. UL Underwriter's Laboratories
12. ETL Intertek
13. ISO Internal Standards Organization 9002 Certified
14. FDA Food & Drug Administration Approval
15. MS Federal Specification GG-SS-1340A

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct virtual or live conference at Project site

1.4 SUBMITTALS

A. Product Data: For each type of product. Include the following:

1. Manufacturer's model number.
2. Accessories and components that will be included in the project.
3. Clearance requirements for access and maintenance.
4. Utility service connections for water, drainage, power.

B. Shop Drawings: Show overall dimensions, utility locations and consumptions, wall opening sizes, and relationships to adjoining structures.

C. Operation & Maintenance Manuals: Includes operating procedures, maintenance schedules, parts list, control and wiring diagrams.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For laboratory sterilization facilities.

1. Indicate locations of laboratory sterilization equipment and connections to utilities.
2. Key equipment using same designations as indicated on drawings.
3. Include plans and elevations; clearance requirements for equipment access and maintenance; details of equipment support; and utility service characteristics.
4. Include details of seismic bracing for equipment, if required for location.

B. Warranty: 1-Year Parts and Labor, 15-Years on Chamber/Pressure Vessel

1.6 QUALITY ASSURANCE

A. Sterilizer manufacturer must have ISO9001 facility with the latest tools and machinery needed for proper assembly of equipment. The manufacturer must have a minimum 25 years experience and over 1,000 installations of equipment specified herein, within the contiguous US.

B. Installation and maintenance services must be provided by an authorized, factory-trained representative located within 130 miles of the destination facility.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Design Requirements:

1. Sterilizing Equipment:

Laboratory Sterilizer (Autoclave): 26W x 26H x 49D Chamber Size, Double, Vertical Sliding Automatic Doors.

2.2 MANUFACTURERS

A. Manufacturer/Model: Products must meet or exceed the specifications of the listed manufacturer below and be approved by the Owner and Design Team, prior to bid submission.

1. Tuttnauer USA Co. Ltd.,

a. Model 66D-EPD2-V-CS

2. Proposed substitutions are to be submitted during bidding including full qualifications for review and assessment of allowance; only pre-approved substitutions to be allowed to bid.

2.3 DESCRIPTION

A. Description: Microprocessor controlled laboratory steam sterilizer, gravity, and pre/post vacuum means of air removal. Equipped with dual, 7" full color touch screens and minimum 20 user customizable cycles, capable of providing suitable sterile processing of glassware, hard goods, animal food/bedding, lightly wrapped porous loads and liquid loads in vented containers. General temperature range shall be from 105°C (221°F) to 137°C (278°F).

B. Internal Chamber Dimensions:

1. 26W x 26H x 49D

C. Door Type:

1. Double: Automatic Vertical Sliding. Smooth Hydraulic operation, no cables, pulleys or motors.

D. Mounting:

1. Double Door: Recessed Through Two Walls.
2. Integral air differential seal with stainless steel mounting frame (mounted and sealed to wall and floor), silicone rubber gasket and all stainless steel mounting hardware.

    a. Air differential seal shall be mounted on load side of autoclave.

E. Construction:

1. Chamber: Minimum 316L Type Stainless Steel. Polished to high luster.
2. Jacket: Minimum 304L Type Stainless Steel. Fully enclosed, dimpled welded design. Sectional U" channels, which only provide a partial jacket, are not acceptable.
3. Vessel Identification: Autoclave shall have one permanently fixed plate stamped in accordance with ASME codes with the following information:

    a. Name & Address of Manufacturer.
    b. Serial Number.
    c. Chamber Pressure Rating.
    d. Jacket Pressure Rating.
    e. Stamp of Inspection Authority.

4. Chamber Penetrations: Sterilizer chamber shall come equipped with (2) TWO 1-inch capped chamber penetration ports for validation, temperature distribution and heat mapping.
5. Baffles: Sterilizer chamber shall be fitted with steam inlet baffles constructed of 316L stainless steel. Baffle design is configured to direct condensate toward the chamber floor and prevent wetting of the load. Baffling also helps to assure proper steam and temperature distribution.
6. Insulation: Chamber and Door are completely insulated with 2-inch rigid insulation and enclosed in stainless steel cladding.
7. Piping Materials: Chamber and Jacket shall be provided with stainless steel piping. All piping shall be threaded, modular in design, with unions placed before and after components to facilitate servicing. All straight piping of 12 inch or more will be insulated.
8. Components:

    a. Stainless steel components in the primary steam supply to chamber. Non-critical components can be stainless steel, brass and copper.

9. Valves: Except where otherwise stated, steam, water, and exhaust valves are solenoid activated, pneumatically operated normally closed valves. All valves shall be of material compatible with the utility service. All valves shall be provided with tags for identification. All pneumatic and hydraulic components shall be standard off the shelf, non-proprietary items. Utility shut-off valves on all supply lines shall be high quality ball type, unless prohibited by local code. (Provided by others)
10. Air Inlet Filter: The air inlet filter, used for vacuum break, shall be a hydrophobic type bacterial retentive absolute air filter 0.2 micron. The air filter shall be mounted external to the chamber with a replaceable element appropriately supported and connected.
11. Sensors and Gauges: All appropriate sensors shall be installed to be easily removed for calibration.

F. Control System:

1. General: The sterilizer control system shall be equipped with a minimum 7-inch full color touch screen on both the clean and dirty side, including a printer and dual emergency shut off switches.
2. Cycles: Pre-Vacuum, Gravity, Liquid.
3. Test Cycles: Vacuum Leak Test, Bowie-Dick Test (Daily Air Removal).
4. Printer: Alphanumeric, thermal printer.
5. USB and Ethernet ports for downloading cycle data and system backup.
6. Multiple access levels and passwords for added security.
7. Minimum 20 cycle capacity.

G. Safety Features:

1. The autoclave door shall be designed with several redundant/independent mechanical and control features that provide safety.

    a. A cycle cannot be started until the door(s) are fully closed and locked.
    b. The door cannot be opened while a cycle is in progress.
    c. The door shall not be unsealed or unlocked until chamber pressure is 2 psi or less.
    d. Clean and dirty side doors cannot be opened at the same time.
    e. After the dirty-side door is opened a successful sterilization cycle must be completed before the clean-side door can be opened.

H. Additional Required Options:

1. Automatic Utility Start-Up/Shutdown: The autoclave's required utilities are set to automatically shut down and start up at a pre-determined time. Operator selected; each timed set point is independent of each other.
2. Water Conserving Effluent Cool Down System: An automatic condenser exhaust system utilizing a drain RTD shall be provided to condense and cool effluent flowing to the external drain. Water temperature shall be below 140°F, in accordance with U.S. National Plumbing Code.
3. Loading Equipment: Loading Cart (with two shelves) and two transfer carriages (all stainless steel)
4. Air Removal: Liquid Ring Vacuum Pump (3-phase, 208V or 480V)
5. Warranty: 1 Year Parts & Labor, 15 Years on Chamber/Pressure Vessel.

2.4 UTILITIES

A. Autoclave requirement:

a. Domestic Cold Water: ¾" NPT, 45 PSI Dynamic Minimum, 13 GPM Peak, <70 Degrees.
b. RO/DI Treated Water for Integral Stainless Steel Electric Steam Generator (1-3 Mohm)
c. Compressed Air: 1/2" NPT, 90 PSI Minimum, 3.5 SCFM
d. Floor Drain: 2" ODT, Floor Sink Recommended
e. Electric: 1-Phase, 120V, 20 AMP Dedicated Circuit

f. Electric: 3-Phase, 208V/100Amps or 480V/44Amps for Integral Stainless Steel Electric Steam Generator (36Kw)

2.3 INSTALLATION

A. The vendor shall provide start-up, testing and user-training for personnel as required to operate equipment.

B. Delivery and installation shall be coordinated so that equipment can be positioned in-place, within the sequence of construction: Contractor shall verify the delivery route through building is adequate for equipment.

C. Equipment to be securely crated and/or packaged to prevent damage during shipment. Loose parts shipped inside of the unit shall be secured.

D. The vendor shall be responsible for delivery of the unit(s) to the job site, unpacking, transport to final location, setting the equipment in place and reassembly, if required.

E. The vendor shall be responsible for the full air differential seal installation, including installation of the air differential seal wall frame.

F. The vendor shall verify that required utilities are available, in proper locations, and ready for use.

G. The vendor will not be responsible for the final utility connections. This scope of work shall be performed by others.

H. Beginning of installation means acceptance of existing conditions by the vendor.

END OF SECTION 115320

SECTION 115353 - BIOLOGICAL SAFETY CABINETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Biological Safety Cabinets

1. Class II, Type B2 Biological Safety Cabinets. Note that all Type II B2 biological safety cabinets are to be furnished by owner and installed by Contractor.

B. See drawings for locations, types, sizes and infrastructure requirements.

C. Connection to utilities.

1.2 RELATED REQUIREMENTS

A. Division 23 for ductwork connections.

B. Division 26 for electrical connections.

1.3 REFERENCE STANDARDS

A. NEMA MG 1 - Motors and Generators 2018.

B. NSF 49 - Biosafety Cabinetry: Design, Construction, Performance, and Field Certification 2016.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate installation of biological safety cabinets with laboratory casework and other laboratory equipment.

1.5 SUBMITTALS

A. Shop Drawings: Show complete construction details, fittings, electrical connection, filters and other information necessary to fully describe each unit and its installation. Include plans and elevations. Include CFM and static pressure requirements. Indicate required installation, operational, and maintenance clearances to wall and ceilings.

B. Product Data: Show test results and performance charts.

C. Manufacturer's Qualification Statement.

D. Installer's Qualification Statement.

E. Operation Data: Include description of equipment operation and required adjusting and testing.

F. Maintenance Data: Identify maintenance requirements, servicing cycles, recertification requirements, and local spare part sources.

G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

H. Field Reports: Start-up report(s) prepared by independent qualified certifier, accredited by NSF to test and balance biological safety cabinets.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:

1. See Section 016000 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum three years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package each piece of equipment to ensure protection from damage during shipment and delivery.

B. Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install biological safety cabinets until building is enclosed, wet work and utility roughing-in is complete, gypsum board, spackling, painting, flooring installation is completed, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.9 WARRANTY

A. Provide manufacture’s standard warranty

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Biological Safety Cabinets basis of design manufacturer - Esco Lifesciences Labculture LB2-5B-E or provide approved equal from one of the following:

1. The Baker Company: www.bakerco.com/#sle.
2. Labconco Corp: www.labconco.com/#sle.
3. NuAire Inc: www.nuaire.com/#sle.

2.2 PERFORMANCE/DESIGN CRITERIA

A. Design meeting requirements of the particular class and type of cabinet.

1. Class II Type B2: Suitable for testing and experimentation with low to moderate risk biological agents may be used for work with volatile toxic chemicals and radionuclide required as part of microbiological research.

2.3 BIOLOGICAL SAFETY CABINETS - CLASS II, TYPE B2

A. General: Enclosed, ventilated cabinet designed to offer personnel, product and environmental protection, while limiting cross-contamination between biological agents inside the cabinet and in surrounding environment. May be used for work with volatile toxic chemicals and radionuclide required as adjunct to microbiological studies.

1. 100 percent exhausted from cabinet to building exterior.

B. Class II B2 Biological Safety Cabinets. Note that all Type II B2 biological safety cabinets are to be furnished Contractor and installed by Contractor.

C. See drawings for locations, types, sizes and infrastructure requirements.

D. Nominal Size: 60”.

E. Work Zone: Nominal dimensions complying with performance specifications for unit specified.

1. Internal Dimensions: 61.8x24.5x28.1H”.

F. Front View Window Opening Height: Fully-closed to 21 inches.

G. Cabinet Style: Benchtop/Console with base stand.

H. Controls: Microprocessor based control system with cleanable membrane touch-screen control panel mounted on the front of the cabinet and facing down towards operator while seated.

1. Audible alarm and flashing LED to indicate unsafe condition.
2. Alarm mute switch on the front of the cabinet to allow a brief time for equipment loading in the work zone. Automatic reactivation of audible alarm after five minutes if the viewscreen sash remains at the improper height. The visible alarm to stay on until safe conditions are reestablished.
3. Delay-Off Timer: For lights, outlets and optional ultraviolet lights. Capable of 15-minute interval settings.

I. Illumination: Externally-mounted fluorescent lighting fixture with solid state ballasts producing an average of 100 footcandles (1076 lux) at work surface, with a minimum of 90 footcandles (968 lux).

J. Electrical Requirements - Dedicated 110-120V, 20 amp, 60 Hz single phase circuit required. Pre-wired cabinet with a 14 foot (4.27 m) power cord terminated with a NEMA 5-20P plug. Two GFCI outlets minimum in the work area protected by an independent self-resetting breaker.

K. Optional Accessories:

1. Channel Stand: Telescoping type, adjustable, with leg levelers, designed to position work surface from 30 inches (762 mm) to 37 inches (940 mm).
2. Footrest: Manufacturer's standard.

2.4 FABRICATION

A. General: Assemble each biological safety cabinet in factory to greatest extent possible.

B. Cabinet Construction: Double-wall construction, with negative pressure airflow between the walls from drain pan to top surrounding sides and back of work area. High-velocity return air slots in side walls and top adjacent to front access opening for enhanced containment and reduction of air turbulence.

C. Cabinet Assembly: Welded, gasketed and/or hermetically sealed joints for cabinet components, capable of achieving a soap-bubble-tested seal when completely assembled.

D. Cabinet Exterior: 16 gauge, 0.063 inches (1.52 mm), cold rolled steel, with baked enamel white finish.

E. Cabinet Interior: One piece, fully-welded 16 gauge, 0.063 inches (1.59 mm) stainless-steel sheet, type 304, no.4 finish, side walls and rear walls with radiused rounded corners. Perforated metal diffuser top of work zone, protecting supply filter.

F. Front View Window: Vertical sliding, frameless, with 1/4 inch (6 mm) thick laminated safety glass at a 10 degree angle from the vertical.

G. Airfoil: Aerodynamic design at bottom of access opening, directing airflow into front grille.

H. Gaskets: Manufacturer's standard closed cell Neoprene, forming airtight and soap-bubble-tight seals to suit installation conditions and cabinet function.

I. Work Surface: Removable dished work surface tray with integral supports.

J. Drain Pan: Unitized pan with radiused corners on every side to facilitate cleaning, with a minimum liquid holding capacity of 1 gal (3.79 L). Stainless ball valve at pan drain outlet.

K. Motor-Blower: Complying with NEMA MG 1; Variable speed, constant airflow 3/4 horsepower ECM motor with VFD controller. Position within BSC unit to promote even filter loading.

L. Supply Air Plenum: Telescoping design air plenum of steel construction with acid-resistant finish. HEPA filters to be front loading, directly clamped, uniformly loaded, and sealed by closed-cell neoprene gaskets.

M. Air Diffuser and Filter Protector: Stainless steel assembly on top of the cabinet.

N. Filters: One supply and one exhaust, scan-tested, zero-probe HEPA Filters, 99.99 percent efficient on 0.3 micron particles by DOP test, serviceable and removable from front of unit.

1. Type B2 Cabinets: Exhaust filter located below.

O. Exhaust Plenum: All steel construction, with acid-resistant finish. Size for adequate volume to provide unidirectional airflow from cabinet.

1. Type B2 Cabinets:
   a. Exhaust Transition Collar: 12 inch (305 mm) diameter. Type 304 stainless steel, with manufacturer's standard finish.

P. Sashes: Front view window guides incorporating a counterweighted pulley system allowing up and down movement, with one-hand low-effort operation.

1. Glass edges covered with metal extruded channel.
2. Glaze with laminated safety glass.
3. Guide rails capable of holding the sash in place regardless of position.
4. Rubber bumpers to cushion sash when fully opened or closed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of biological safety cabinets.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install biological safety cabinets in compliance with shop drawings and manufacturer's written instructions.

B. Connect to facility utilities.

3.3 FIELD QUALITY CONTROL

A. Employ a qualified, independent testing agency to test and/or inspect installed biological safety cabinets; provide access and assistance as required to accommodate timely completion of testing.

B. Field certify biological safety cabinets, using procedures described in Annex F of NSF 49, current edition.

1. Perform the following tests directly related to containment (i.e., personnel and environmental protection), and product protection:
    a. Downflow velocity profile test.
    b. Inflow velocity test.
    c. Airflow smoke patterns test.
    d. HEPA filter leak test.
    e. Site installation assessment tests, including:
        1) Alarm functions as required by the referenced standard.

C. Make the necessary corrections and retest units that do not meet specified standards.

D. Affix to the cabinet a certificate of satisfactory performance when the cabinet meets all field test criteria.

3.4 ADJUSTING

A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Verify that counterbalances operate without interference.

3.5 CLEANING

A. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

B. Clean adjacent construction and surfaces that may have been soiled or damaged in the course of installation of work in this section.

C. Provide all necessary protective measures to prevent exposure of equipment and surfaces to other construction activity.

END OF SECTION 115353

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 12 35 53 – STAINLESS STEEL LABORATORY CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Stainless steel laboratory casework
2. Stainless steel filler and closure panels.
3. Stainless steel countertops.

1.3 COORDINATION

A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.

B. Coordinate installation of laboratory casework with installation of fume hoods and other laboratory equipment.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For laboratory casework. Include plans, elevations, sections, and attachment details.

1. Indicate types and sizes of cabinets.
2. Indicate locations of hardware.
3. Indicate locations and types of service fittings.
4. Indicate locations of blocking and reinforcements required for installing laboratory casework.
5. Include details of support framing system.
6. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
7. Include coordinated dimensions for laboratory equipment specified in other Sections.

C. Samples for Verification: For each type of cabinet finish and each type of countertop material, in manufacturer's standard sizes.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Test Reports for Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified product standard.

C. Product Test Reports for Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface materials with requirements specified for chemical and physical resistance.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Mounting Clips and Related Hardware: Quantity equal to 5 percent of amount installed, but no fewer than 6 of each type.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that produces casework of types indicated for this Project that has been tested for compliance with SEFA 8 M.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, utility roughing-in and wet work are complete and dry, and temporary HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before being enclosed, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kewaunee Scientific Corporation; Laboratory Products Group.
2. Jamestown Metal Products Inc.
3. Mott Manufacturing Ltd.
4. H2I Group
5. Or equal if and as specifically approved by Architect by Addendum during the bidding period.

B. Source Limitations: Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.

C. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes and similar door and drawer configurations and complying with Specifications may be considered.

2.2 CASEWORK, GENERAL

A. Casework Product Standard: Comply with SEFA 8 M, "Laboratory Grade Metal Casework."

2.3 METAL CABINET AND TABLE MATERIALS

A. Metal: Mild. cold-rolled and leveled #304 stainless steel. (#4 polished sheen on all exposed surfaces).

B. Nominal Metal Thickness:

1. Sides, Ends, Fixed Backs, Bottoms, Tops, Soffits, and Items Not Otherwise Indicated: 0.048 inch (1.21 mm). Except for flammable liquid storage cabinets, bottoms may be 0.036 inch (0.91 mm) if reinforced.
2. Back Panels, Doors, Drawer Fronts and Bodies, and Shelves: 0.036 inch (0.91 mm) except 0.048 inch (1.21 mm) for back panels and doors of flammable liquid storage cabinets and for unreinforced shelves more than 36 inches (900 mm) long.
3. Intermediate Horizontal Rails, Table Aprons and Cross Rails, Center Posts, and Top Gussets: 0.060 inch (1.52 mm).
4. Drawer Runners, Sink Supports, and Hinge Reinforcements: 0.075 inch (1.90 mm).
5. Leveling and Corner Gussets: 0.105 inch (2.66 mm).

2.4 AUXILIARY CABINET MATERIALS

A. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.

2.5 METAL CABINETS AND TABLES

A. Fabrication: Assemble and finish units at point of manufacture. Use precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels. Except where otherwise specified, integrally frame and weld cabinet bodies to form dirt- and vermin-resistant enclosures. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch (1.5 to 2.4 mm).

B. Flush Doors: Outer and inner pans that nest into box formation, with full-height channel reinforcements at center of door. Fill doors with noncombustible, sound-deadening material.

C. Glazed Doors: Hollow-metal stiles and rails of similar construction as flush doors, with glass held in resilient channels or gasket material.

D. Hinged Doors: Mortise for hinges and reinforce with angles welded inside inner pans at hinge edge.

E. Drawers: Fronts made from outer and inner pans that nest into box formation, with no raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Provide drawers with rubber bumpers, polymer roller slides, and positive stops to prevent metal-to-metal contact or accidental removal.

F. Adjustable Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.

G. Upper Cabinets: Provide sloped tops in same cabinet material at all upper cabinets.

H. Toe Space: Fully enclosed, 4 inches (100 mm) high by 3 inches (75 mm) deep, with no open gaps or pockets.

I. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets and with hemmed or flanged edges unless otherwise indicated.

1. Provide knee-space panels (modesty panels) at spaces between base cabinets, where indicated. Fabricate from back-to-back panels or of hollow construction to eliminate exposed hemmed or flanged edges.
2. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.

3. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.

2.6 HARDWARE

A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

B. Hinges: Stainless-steel, five-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two for doors 48 inches (1200 mm) high or less and three for doors more than 48 inches (1200 mm) high.

C. Hinged Door and Drawer Pulls: Stainless-steel back-mounted pulls. Provide two pulls for drawers more than 24 inches (600 mm) wide.

1. Design: Wire pulls.
2. Overall Size: 1-1/4 by 4-1/2 inches (32 by 114 mm).

D. Door Catches: Nylon-roller spring catches. Provide two catches on doors more than 48 inches (1200 mm) high.

E. Ball Bearing Drawer Slides:

1. Acceptable Manufacturers:

a. Base:

1) Accuride.

b. Optional:

1) Waterloo Furniture Components Inc.
2) Fulterer USA
3) Or equal if and as specifically approved by Architect by Addendum during the bidding period.

2. Typical Drawers:

a. Satisfy ANSI/BHMA Grade 1 HD requirements.
b. Basis of Design:

1) For drawer widths up to 460mm 18 IN: Accuride 4033 (light-duty polymer ball bearings).
2) For drawer widths greater than 460mm 18 IN and up to 685mm 27 IN: Accuride 4032 (medium duty stainless steel ball bearings).

3) For drawer widths greater than 685mm 27 IN and up to 1065mm 42 IN: Accuride 930.

c. Full extension.
d. Dynamic Load Rating: 45 kg/pair 100 LB/PAIR capacity, minimum.

3. Base Metal:
a. Sheet metal to match cabinet construction.

2.7 COUNTERTOPS, AND SHELVES ,

A. Stainless-Steel Countertops: Made from stainless-steel sheet, not less than 0.062-inch (1.59-mm) nominal thickness, with No. 4 satin finish.

1. Extend top down 1 inch (25 mm) at edges with a 1/2-inch (13-mm) return flange under frame. Apply heavy coating of heat-resistant, sound-deadening mastic to undersurface.
2. Form backsplash coved to and integral with top surface.
3. Provide raised (marine) edge where indicated.
4. Factory punch holes for service fittings.
5. Reinforce underside of countertop with channels, or use thicker metal sheet where necessary to ensure rigidity without deflection.
6. Weld shop-made joints.
7. Where field-made joints are required, provide hairline butt joints mechanically bolted through continuous channels welded to underside at edges of joined ends. Keep field jointing to a minimum.
8. Where stainless-steel sinks or cup sinks occur in stainless-steel countertops, factory weld into one integral unit.
9. After fabricating and welding, grind surfaces smooth, and polish as needed to produce uniform, directionally textured finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

B. Stainless-Steel Shelves: Made from stainless-steel sheet, not less than 0.050-inch (1.27-mm) nominal thickness, with No. 4 satin finish. Weld shop-made joints. Fold up front edge 3/4 inch (19 mm); fold up back edge 3 inches (75 mm). Provide integral stiffening brackets, formed by folding up ends 3/4 inch (19 mm) and welding to upturned front and back edges. After fabricating, grind welds smooth, and polish as needed to produce uniform, directionally textured finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CABINETS

A. Comply with installation requirements in SEFA 2.3. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:

1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet (1.5 mm in 3 m).
2. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet (3 mm in 3 m).
3. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet (3 mm in 3 m).
4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch (0.8 mm).
5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch (1.5 mm).

B. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 16 inches (400 mm) o.c.

C. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.

D. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF COUNTERTOPS

A. Comply with installation requirements in SEFA 2.3. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where indicated on Shop Drawings.

B. Field Jointing: Where possible, make in same manner as shop-made joints, using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Shop prepare edges for field-made joints.

1. Use concealed clamping devices for field-made joints in plastic-laminate countertops. Locate clamping devices within 6 inches (150 mm) of front and back edges and at

intervals not exceeding 24 inches (600 mm). Tighten according to manufacturer's written instructions to exert a uniform heavy pressure at joints.

C. Provide required holes and cutouts for service fittings.

D. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

E. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.4 INSTALLATION OF SINKS

A. Comply with installation requirements in SEFA 2.3.

B. Semiflush Installation of Stainless-Steel Sinks: Before setting, apply sink and countertop manufacturers' recommended sealant under rim lip and along top. Remove excess sealant while still wet and finish joint for neat appearance.

3.5 INSTALLATION OF LABORATORY ACCESSORIES

A. Install accessories according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions.

B. Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.

C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.

D. Securely fasten pegboards to partition framing, wood blocking, or reinforcements in partitions.

3.6 CLEANING AND PROTECTING

A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

B. Protect countertop surfaces during construction with 6-mil (0.15-mm) plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches (1200 mm) o.c.

END OF SECTION 12 35 53

SECTION 13 34 19 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Structural-steel framing.
2. Metal roof panels.
3. Sheet metals/flashings.
4. Foam-insulation-core metal wall panels.
5. Metal soffit panels.
6. Thermal insulation.
7. Accessories.

1.3 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of metal building system component. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

1. Structural-steel-framing system.
2. Metal roof panels.
3. Metal wall panels.
4. Insulation and vapor retarder facings.
5. Flashing and trim.
6. Accessories.

B. Shop Drawings: For the following metal building system components. Include plans, elevations, sections, details, and attachments to other work.

1. Anchor-Bolt Plans: Submit anchor-bolt plans and templates before foundation work begins. Include location, diameter, and projection of anchor bolts required to attach metal building to foundation. Indicate column reactions at each location.
2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.
3. Metal Roof and Wall Panel Layout Drawings: Show layouts of metal panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.

    a. Show wall-mounted items including doors, windows, louvers, and lighting fixtures.

4. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:

    a. Flashing and trim.
    b. Gutters.
    c. Downspouts.

C. Samples for Initial Selection: For units with factory-applied color finish.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below:

1. Metal Panels: Nominal 12 inches long by actual panel width. Include fasteners, closures, and other exposed panel accessories.

E. Delegated-Design Submittal: For metal building systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer licensed to practice in the State of Missouri responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified erector, manufacturer, professional engineer and land surveyor.

B. Manufacturer Accreditation: Statement that metal building system and components were designed and produced by a manufacturer accredited according to the International Accreditation Service's AC472.

C. Metal Building System Certificates: For each type of metal building system, from manufacturer.

1. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

    a. Name and location of Project.
    b. Order number.
    c. Name of manufacturer.
    d. Name of Contractor.
    e. Building dimensions including width, length, height, and roof slope.
    f. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
    g. Governing building code and year of edition.
    h. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
    i. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
    j. Building-Use Category: Indicate category of building use and its effect on load importance factors.

D. Erector Certificates: For each product, from manufacturer.

E. Manufacturer Certificates: For each product, from manufacturer.

F. Material Test Reports: For each of the following products:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shop primers.
5. Nonshrink grout.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for insulation and vapor-retarder facings. Include reports for thermal resistance, fire-test-response characteristics, water-vapor transmission, and water absorption.

H. Source quality-control reports.

I. Field quality-control reports.

J. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer and member of MBMA.

1. Accreditation: According to the International Accreditation Service's AC472.
2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in jurisdiction where Project is located.

B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

E. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings," for design requirements and allowable stresses.

F. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

G. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to metal building systems including, but not limited to, the following:

a. Condition of foundations and other preparatory work performed by other trades.
b. Structural load limitations.
c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
d. Required tests, inspections, and certifications.
e. Unfavorable weather and forecasted weather conditions.

2. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
b. Structural limitations of purlins and rafters during and after roofing.
c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.

d. Temporary protection requirements for metal roof panel assembly during and after installation.
e. Roof observation and repair after metal roof panel installation.

3. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:

a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
b. Structural limitations of girts and columns during and after wall panel installation.
c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
d. Temporary protection requirements for metal wall panel assembly during and after installation.
e. Wall observation and repair after metal wall panel installation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

1.9 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements:

1. Established Dimensions for Foundations: Comply with established dimensions on approved anchor-bolt plans, establishing foundation dimensions and proceeding with fabricating structural framing without field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.
2. Established Dimensions for Metal Panels: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements, or allow for field trimming metal

panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 25 years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roofing, sheet metal, and flashings: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies, sheet metal, flashings that leak or otherwise fail to remain weathertight within specified warranty period.

1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

1. Butler Manufacturing Company.
2. Varco Pruden.
3. Nucor Building Systems.

4. Ceco Metal Building Systems.
5. Approval of other manufacturers subject to acceptance prior to bidding.

2.2 METAL BUILDING SYSTEMS

A. Description: Provide a complete, integrated set of metal building system manufacturer's standard mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.

1. Provide metal building system of size and with bay spacings, roof slopes, and spans indicated.

B. Primary-Frame Type:
1. Rigid Modular: Solid-member, structural-framing system with interior columns.

C. End-Wall Framing: Manufacturer's standard, for buildings not required to be expandable, consisting of primary frame, capable of supporting one-half of a bay design load, and end-wall columns.

D. Secondary-Frame Type: Manufacturer's standard purlins and joists and exterior-framed (bypass) girts.

E. Eave Height: As indicated.

F. Bay Spacing: As indicated

G. Roof Slope: As indicated.

H. Roof System: Metal roof panels to match panel profile and color of in-place Phase 1 building adjacent to proposed addition; basis – Ceco Building System, Battonlok.

I. Exterior Wall and Roof Soffit Panel System: Foam-insulation core metal wall panels to match panel profile and color of in-place Phase 1 building adjacent to proposed addition; basis - Ceco Building Systems, Striated IMP:

1. 26 gage interior, 24 gage exterior stucco-embossed metal skins.
2. PVDF coating over Galvalume substrate – basis Signature 300.
3. 2 ½” non-CFC polyurethane foamed-in-place core, minimum R-19 panel value.
4. 42” wide panel.
5. Concealed clip and fastener system.

J. Canopy Soffit Panels: 26 gauge (minimum) corrugated. Perforated metal panels, finish to match adjacent wall panels.

2.3 METAL BUILDING SYSTEM PERFORMANCE

A. Delegated Design: Design metal building system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Metal building systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."

1. Design Loads: As indicated on Drawings.

2. Design Loads: As required by ASCE/SEI 7.
3. Deflection Limits: Design metal building system assemblies to withstand design loads with deflections no greater than the following:

    a. Main framing members: Vertical deflection of 1/240.
    b. Purlins and Rafters: Vertical deflection of 1/180 of the span.
    c. Girts: Horizontal deflection of 1/180 of the span.
    d. Metal Roof Panels: Vertical deflection of 1/180 of the span.
    e. Metal Wall Panels: Horizontal deflection of 1/180 of the span.
    f. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.

4. Drift Limits: Engineer building structure to withstand design loads with drift limits no greater than the following:

    a. Lateral Drift: Maximum of 1/160 of the building height.

5. Metal panel assemblies shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated according to ASTM E 1592.

C. Seismic Performance: Metal building systems shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Air Infiltration for Metal Roof Panels: Air leakage through assembly of not more than 0.008 cfm/sq. ft. of roof area when tested according to ASTM E 1680 at negative test-pressure difference of 6.24 lbf/sq. ft.

F. Air Infiltration for Metal Wall Panels: Air leakage through assembly of not more than 0.006 cfm/sq. ft. of wall area when tested according to ASTM E 283 at static-air-pressure difference of 6.24 lbf/sq. ft.

G. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E 1646 at test-pressure difference of 12.0 lbf/sq. ft.

H. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E 331 at a wind-load design pressure of not less than 12.0 lbf/sq. ft.

I. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for Class 90.

J. Thermal Performance: Provide insulated metal panel assemblies with the following maximum U-factors and minimum R-values for opaque elements when tested according to ASTM C 1363 or ASTM C 518:

1. Metal Roof Assemblies:
   a. R-Value: 30 min.

2. Metal Wall Panel Assemblies:
   a. R-Value: 19 min.

2.4 STRUCTURAL-STEEL FRAMING

A. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafter, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

   a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.
2. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from round steel pipes or tubes, or shop-welded, built-up steel plates.
3. Frame Configuration: Single gable.
4. Exterior Column Type: Strait.
5. Rafter Type: Tapered.

B. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:

1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.
2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.

C. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, to comply with the following:

1. Purlins: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes.

    a. Depth: As needed to comply with system performance requirements.
2. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
3. Flange Bracing: Minimum 2-by-2-by-1/8-inch structural-steel angles or 1-inch- diameter, cold-formed structural tubing to stiffen primary-frame flanges.
4. Sag Bracing: Minimum 1-by-1-by-1/8-inch structural-steel angles.
5. Base or Sill Angles: Minimum 3-by-2-inch zinc-coated (galvanized) steel sheet.
6. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
7. Secondary End-Wall Framing: Manufacturer's standard sections fabricated from zinc-coated (galvanized) steel sheet.
8. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
9. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

D. Canopy Framing: Manufacturer's standard structural-framing system, designed to withstand required loads; fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide frames with attachment plates and splice members, factory drilled for field-bolted assembly.

E. Bracing: Provide adjustable wind bracing as follows:

1. Rods: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50; or ASTM A 529/A 529M, Grade 50; minimum 1/2-inch- diameter steel; threaded full length or threaded a minimum of 6 inches at each end.
2. Cable: ASTM A 475, 1/4-inch- diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.

F. Bolts: Provide plain-finish bolts for structural-framing components that are primed or finish painted. Provide hot-dip galvanized bolts for structural-framing components that are galvanized.

G. Materials:

1. W-Shapes: ASTM A 992/A 992M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
3. Plate and Bar: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
4. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
5. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B or C, structural tubing.
6. Structural-Steel Sheet: Hot-rolled, ASTM A 1011/A 1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low-Alloy Steel (HSLAS), Grades 45 through 70; or cold-rolled, ASTM A 1008/A 1008M, Structural Steel (SS), Grades 25 through 80, or High-Strength Low-Alloy Steel (HSLAS), Grades 45 through 70.
7. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80 or High-Strength Low-Alloy Steel (HSLAS), Grades 50 through 80; with G60 coating designation; mill phosphatized.
8. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80 or High-Strength Low-Alloy Steel (HSLAS), Grades 50 through 80; with G90 coating designation.
    b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Structural Steel (SS), Grade 50 or 80; with Class AZ50 coating.

9. Non-High-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A, carbon-steel, hex-head bolts; ASTM A 563 carbon-steel hex nuts; and ASTM F 844 plain (flat) steel washers.

    a. Finish: Plain.

10. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563 heavy-hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

    a. Finish: Plain.

11. Unheaded Anchor Rods: ASTM F 1554, Grade 36.

    a. Configuration: Straight.
    b. Nuts: ASTM A 563 heavy-hex carbon steel.
    c. Plate Washers: ASTM A 36/A 36M carbon steel.

d. Washers: ASTM F 436 hardened carbon steel.
e. Finish: [Plain] [Hot-dip zinc coating, ASTM A 153/A 153M, Class C].

12. Headed Anchor Rods: ASTM F 1554, Grade 36.

a. Configuration: Straight.
b. Nuts: ASTM A 563 heavy-hex carbon steel.
c. Plate Washers: ASTM A 36/A 36M carbon steel.
d. Washers: ASTM F 436 hardened carbon steel.
e. Finish: [Plain] [Hot-dip zinc coating, ASTM A 153/A 153M, Class C].

13. Threaded Rods: ASTM A 36/A 36M.

a. Nuts: ASTM A 563 heavy-hex carbon steel.
b. Washers: ASTM F 436 hardened carbon steel.
c. Finish: Plain.

2.5 METAL ROOF PANELS

A. Tapered-Rib-Profile, Lap-Seam Metal Roof Panels : Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Match profile of existing Phase 1 building.

1. Material: Zinc alloy-coated steel sheet, 0.018-inch nominal thickness.

a. Exterior Finish: Fluoropolymer.
b. Color: Custom to match existing building.

2. Major-Rib Spacing: Match existing.

B. Materials:

1. Metallic-Coated Steel Sheet: Restricted-flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

a. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 50; structural quality.
b. Surface: Smooth, flat finish.

C. Finishes:

1. Exposed Coil-Coated Finish:
a. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.6 FOAM-INSULATION-CORE METAL WALL PANELS

A. Description: Provide factory-formed and -assembled, metal wall panels fabricated from two metal facing sheets and an insulation core foamed in place during fabrication, with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

1. Concealed-Fastener, Foam-Insulation-Core Metal Wall Panels : Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

    a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
    b. Exterior Surface: Striatedstucco-embossed.
    c. Panel Coverage: 42 inchesnominal.
    d. Panel Thickness: 2.5 inches.
    e. Thermal-Resistance Value (R-Value): 19 min.

B. Panel Performance:

1. Flatwise Tensile Strength: 30 psi when tested according to ASTM C 297/C 297M.
2. Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for seven days at 140 deg F and 100 percent relative humidity according to ASTM D 2126.
3. Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for seven days at 200 deg F according to ASTM D 2126.
4. Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for seven days at minus 20 deg F according to ASTM D 2126.
5. Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. positive and negative wind load and with deflection of L/180 for two million cycles.
6. Autoclave: No delamination when exposed to 2-psi pressure at a temperature of 212 deg F for 2-1/2 hours.
7. Fire-Test-Response Characteristics: Class A according to ASTM E 108.

C. Polyisocyanurate Insulation-Core Performance:

1. Density: 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D 1622.
2. Compressive Strength: Minimum 20 psi when tested according to ASTM D 1621.
3. Shear Strength: 26 psi when tested according to ASTM C 273/C 273M.

D. Materials:

1. Polyisocyanurate Insulation: Modified polyisocyanurate foam using a non-CFC blowing agent, foamed-in-place or board type as indicated, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.

    a. Closed-Cell Content: 90 percent when tested according to ASTM D 6226.

2. Metallic-Coated Steel Sheet: Restricted-flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
    b. Surface: Embossed finish.

E. Finishes:

1. Exposed Coil-Coated Finish:
    a. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.7 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

B. Metal Roof Soffit Panels: Match profile and material of metal wall panels.

C. Finish: Match finish and color of metal roof panels.Canopy Soffit Panels: tapered-rib-profile at canopies: Exposed-Fastener Perforated Metal Soffit Panels : Formed with raised, trapezoidal major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.
   a. Exterior Finish: Fluoropolymer.
   b. Color: Custom to match existing building.

2.8 THERMAL INSULATION

A. Unfaced Metal Building Roof Insulation: ASTM C 991, Type I, or NAIMA 202, glass-fiber-blanket insulation; 0.5-lb/cu. ft. density; 2-inch- wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

   1. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm when tested according to ASTM E 96/E 96M, Desiccant Method.
      a. Composition: White polypropylene film facing and fiberglass-polyester-blend fabric backing.

2.9 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

   1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

   1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
   2. Clips: Manufacturer's standard, formed from steel sheet, designed to withstand negative-load requirements.
   3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from steel sheet.
   4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
   5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch standoff; fabricated from extruded polystyrene.

C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
2. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

D. Flashing and Trim: Formed from 0.022-inch nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
2. Opening Trim: Formed from 0.022-inch nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

E. Gutters: Formed from 0.022-inch nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

1. Gutter Supports: Fabricated from same material and finish as gutters.
2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

F. Downspouts: Formed from 0.022-inch nominal-thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

G. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

H. Materials:

1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.

    a. Fasteners for Metal Roof Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless-steel cap or zinc-aluminum-alloy head and EPDM sealing washer.
    b. Fasteners for Metal Wall Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws.
    c. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
    d. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

2. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
3. Metal Panel Sealants:

    a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
    b. Joint Sealant: ASTM C 920; one-part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.10 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.
2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing.
5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll-forming or break-forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.
2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written erection instructions and erection drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for bolt type and joint type specified.

    a. Joint Type: Snug tightened or pretensioned.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Locate canopy framing as indicated.
4. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod to avoid sag.
2. Locate interior end-bay bracing only where indicated.

I. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

J. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 METAL PANEL INSTALLATION, GENERAL

A. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.

B. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

    a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports unless otherwise indicated.

3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over, but not attached to, structural supports with end laps in alignment.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.

3.5 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

1. Install ridge caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.
2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
4. At metal panel splices, nest panels with minimum 6-inch end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

C. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

D. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction.
4. Flash and seal metal wall panels with weather closures at eaves, rakes, duct penetrations, and at perimeter of all openings. Fasten with self-tapping screws.
5.
6. Install flashing and trim as metal wall panel work proceeds.
7. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated; or, if not indicated, as necessary for waterproofing.
8. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
9. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.

C. Insulated Metal Wall Panels: Install insulated metal wall panels on exterior side of girts. Attach panels to supports at each panel joint using concealed clip and fasteners at maximum 42 inches o.c., spaced not more than manufacturer's recommendation. Fully engage tongue and groove of adjacent insulated metal wall panels.

1. Install clips to supports with self-tapping fasteners.
2. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels as weather seal.

D. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 feet, nonaccumulative, on level, plumb, and on location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.7 METAL SOFFIT PANEL INSTALLATION

A. Provide metal soffit panels the full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.8 THERMAL INSULATION INSTALLATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, according to manufacturer's written instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.

3. Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.

    a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

4. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

3.9 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
1. Tie downspouts to underground drainage system indicated.

E. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.10 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 13 34 19

SECTION 21 05 00 - BASIC FIRE SUPPRESSION REQUIREMENTS

1. GENERAL

1.1 SECTION INCLUDES

A. This section describes Basic Fire Suppression Requirements required to provide for a complete installation of all fire suppression systems for this project. This section shall apply to all other Division 21 specification sections as well as all work shown on the drawings.

B. It is the intent of the Fire Suppression Division of the Specifications that all mechanical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations operate as designed.

C. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's representative and the Authority Having Jurisdiction.

D. The Contractor shall note that, in some cases, piping as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference-free systems with proper clearance to facilities and equipment.

E. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section and all other sections of Division 21.

1.3 DESCRIPTION OF WORK

A. The work included under this section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete fire suppression systems required by these specifications and/or shown on the drawings of the contract.

B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, piping, etc.

1.4 QUESTIONS OF INTERPRETATION

A. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Architect/Engineer for clarification. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date. Verbal interpretation or explanation not issued in the form of an addendum shall not be considered part of the bidding documents. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.

B. The Architect/Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.5 CONTRACT DOCUMENT DISCREPANCIES

A. If any ambiguities should appear in the contract documents, the Contractor shall request clarification from the Architect/Engineer before proceeding with the work. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Architect/Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Architect/Engineer was requested and obtained before submission of bid.

B. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of three-dimensional objects. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies should be identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

C. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of materials or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.

D. If there is a conflict between manufacturer's recommendations and the Contract Documents, the manufacturer's recommendations shall govern with no additional cost to the Owner.

1.6 PERMITS

A. The Contractors shall familiarize themselves with all requirements regarding all permits, fees, etc., and shall comply with them. All permits, licenses, inspections and arrangements required for the work shall be obtained by the Contractor at his expense.

B. All utilities shall be installed in accordance with the local rules and regulations and all charges shall be paid by the Contractor.

1.7 QUALITY ASSURANCE

A. Installers shall have at least 2 years of successful installation experience on projects with fire suppression installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation, unless noted otherwise in other fire suppression sections.

B. Manufacturer of equipment and materials must be regularly engaged in the manufacture of the specified equipment and material with similar construction and capacities and whose products have been in satisfactory use in similar service for not less than five (5) years, unless noted otherwise in other Fire Suppression Sections.

C. Qualify welding processes and operators for structural steel according to AWS D1.1. "Structural Welding Code - Steel.

D. Quality welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Comply with provisions of NFPA 13, NFPA 14, and NFPA 24, including all addenda.

F. Contractor signed welder certificate(s) shall be submitted. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current. A record shall be maintained on the job site showing the date and results of qualification tests for each welder employed on the job. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner's representative.

1.8 REFERENCES

A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall, at minimum, conform to the following as applicable:

1. Safety and Health Regulations for Construction.
2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
3. ACGIH - American Conference of Governmental Industrial Hygienists.
4. AIHA - American Industrial Hygiene Association.
5. AMCA - Air Movement and Control Association.
6. ANSI - American National Standards Institute.
7. ASA - Acoustical Society of American.
8. ASHRAE - American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
9. ASME - The American Society of Mechanical Engineers.
10. ASTM - American Society of Testing and Materials.
11. CAGI - Compressed Air and Gas Institute.
12. CTI - Cooling Tower Institute.
13. EJMA - Expansion Joint Manufacturers Association.

14. ETL - Engineering Tests Laboratory.
15. HI - Hydraulic Institute.
16. HYD I - Hydronics Institute.
17. ICBO - International Conference of Building Officials.
18. ICC – International Code Council.
19. NEBB - National Environmental Balancing Bureau.
20. NEC - National Electrical Code.
21. NEMA - National Electrical Manufacturers Association.
22. NFPA - National Fire Protection Association.
23. NSF - National Sanitation Foundation.
24. SAE - Society of Automatic Engineers.
25. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
26. TEMA - Tubular Exchanger Manufacturers Association.
27. UL - Underwriters Laboratories, Inc.
28. International Plumbing Code.
29. International Mechanical Code.
30. Other governing, state, and local codes that apply.

1.9 SUBMITTALS

A. General: Follow the procedures specified in Division 1 Sections "General Conditions" and “Special Conditions”.

1. See Section 21 13 13 for special submittal procedures for sprinkler/standpipe system submittals.

B. The Architect/Engineer’s review of submittals, including any corrections or comments made on the shop drawings during the review process, do not relieve Contractor from compliance with requirements of the Contract Documents. The review is only a review of general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. The Contractor is responsible for confirming and correlating all quantities and dimensions; selecting fabrication process and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner. The Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data or samples by the Architect/Engineer’s review of those drawings.

C. No portion of the work requiring submission of a shop drawing, product data or sample shall be commenced until the submittal has been reviewed by the Architect/Engineer. All such portions of the work shall be in accordance with reviewed submittals and the associated manufacturer recommendations.

D. Shop drawings shall include the minimum following information as applies. Additional specific information required is outlined in other Fire Suppression Sections.

1. Certified performance and data with system operating conditions indicated.

2. All equipment items shall be marked with the same item number as used on drawings or schedules.
3. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicating, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
4. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, and methods of assembly of components.
5. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to electrical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
6. Maintenance Data: Submit maintenance data and parts list for each fire suppression equipment, control and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

E. Coordination drawings

1. Drawings:

a. Provide coordination in determining adequate clearance and space requirements for fire suppression equipment, mechanical equipment, electrical equipment, and other items/equipment in the project. The Architect/Engineer reserves the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades. The Architect/Engineer will only review conflicts and give an opinion but will not perform as a coordinator.

b. Provide coordination drawings indicating new and existing structural components, reflected ceiling layout, fire suppression items, mechanical items, electrical items, and other systems. Indicate on the coordination drawings where components will be installed and how the service access area to such items shall be maintained. Illustrate items requiring access for maintenance or adjustment.

c. The Contractor will not be allowed any time extensions for participation in the coordination drawing process. The Contractor will not be allowed any contract cost extra for any additional fittings, rerouting or changes of duct size to equivalent sizes to those shown on the drawings that may be determined necessary through the coordination drawing process.

d. Deviations from the contract documents that are necessary for overall system installation and coordination shall be brought to the attention of the Architect/Engineer. Such necessary changes in the contract scope discovered through the coordination drawing process will be covered by the requirements of the "change order" process.

e. Access panels shall occur only in gypsum wallboard or plaster ceilings where indicated on the drawings or as needed to provide access to equipment, dampers, or valves. Access to fire suppression and other items shall be through accessible acoustical ceiling areas. Additional access panels will not be allowed without written approval from the Architect/Engineer at the coordination drawing stage and only after alternatives are reviewed. Layout changes shall be made to avoid additional access panels. If additional access panels are required, they shall be provided at no additional cost to the Owner.

f. Soffit penetrations and light alcoves shall be fully coordinated with hanging devices, studs, fire/smoke ratings, and structural support requirements.

2. Drawings shall be prepared at 1/4 inch = 1 foot, 0 inches (minimum).

a. Coordination participants shall provide equipment installation and clearance requirements. This information shall be indicated on the coordination drawings.

b. Coordination drawings shall indicate the following major system components (including insulation, hub or connection widths with verification of turning radius):

1) Roof drain leaders
2) Large waste piping
3) Sprinkler mains
4) Equipment located above the ceiling
5) Heating hot water piping
6) Chilled water piping
7) Conduit runs 2 inches and larger
8) Cable tray
9) Bus duct
10) Recessed light fixtures
11) Building wiring or cable trays
12) Ceiling heights as shown in contract documents and thickness of system
13) Soffits (including framing of supports)
14) Access points and clearances required
15) Access panels
16) Valves
17) Dampers
18) Coils
19) Ductwork
20) Fire-rated wall, partition, and floor penetrations
21) Steam and condensate piping
22) Space allotted for future utilities
23) Equipment in mechanical and electrical spaces

c. Information shall be delineated to indicate distances from column centerlines, pipe/equipment size, and distance from finished floor to bottom of pipe/equipment and hangers.

3. The coordination drawings shall be submitted to the Architect/Engineer and Owner's representative for review. The submitted coordination drawings shall indicate which contractors participated in the process and where conflicts appear to occur even after the priority ranking of utility routing has been utilized. In the event that conflicts require input from the Architect/Engineer, recommended solutions will be provided with the coordination drawings for review by the Architect/Engineer. The Architect/Engineer will review and return an opinion to the contractors for implementation. All contractors shall agree to the final coordinated layout by signing off on the coordination drawings before any construction can begin.

4. Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Architect/Engineer and the Owner for review on a monthly basis with changes "clouded" and brought to the attention of the Architect/Engineer and the Owner.

5. When a change order request is issued, the affected subcontractors shall review the coordination drawings and bring to the attention of the Contractor and the Architect/Engineer revisions necessary to the work of others not directly affected by the change order.

6. Contractors that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through accessible ceilings. Conflicts that result after the coordination drawings are signed off will be the responsibility of the Contractor or subcontractor who did not properly identify their work or installed the work improperly.

1.10 SUBSTITUTES

A. All proposals shall be based on providing and installing the materials or items of equipment which are hereinafter specified. The Contractor's options in selecting materials and equipment are limited by requirements of the Contract Documents and governing regulations. They are not controlled by industry traditions or procedures experienced by the Contractor on previous construction projects.

B. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing. Associated fire suppression and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are to be increased accordingly, but all recommended manufacturer clearances, etc., are to be maintained within the allotted fire suppression spaces. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

C. Where the terms "or equivalent" is used, the Contractor may substitute alternate equipment, materials, etc. subject to review by the Architect/Engineer and the Owner's representative during the submittal phase of the project.

D. Where the term "or approved equivalent" is used, the Contractor may not substitute alternate equipment, materials, etc. unless requesting approval at least ten (10) days before the bid date. Notifications of any such approvals by the Architect/Engineer shall only be made in writing by Addendum.

E. Where the term "no equivalent" is used, the Contractor must provide the specified or scheduled equipment, materials, etc.

F. Final determination regarding substitutions shall be by the Architect/Engineer.

1.11 WARRANTY

A. Refer to the General Conditions section of this Specification for general warranty requirements and information. Additional warranty requirements are specified in subsequent Fire Suppression Sections.

1.12 CLOSE OUT AND OPERATION INSTRUCTIONS

A. Operate each system and item of equipment in a test run of appropriate duration, but no less than 7 days, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.

B. Systems shall not be used for temporary operation during construction without written approval from the Architect/Engineer and the Authority Having Jurisdiction. If approved and used during construction, all systems must be properly maintained and operated according to manufacturer recommendations. Immediately prior to turnover to the Owner, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

C. Any system placed in temporary operation for testing during construction shall be properly maintained and operated by the Contractor.

D. All systems shall be protected against freezing, flooding, corrosion or other forms of damage prior to acceptance by the Owner.

E. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced to the satisfaction of the Owner's representative.

F. All tests shall be made after notification to and in the presence of the Owner's representative.

G. Before starting up any system, each piece of equipment comprising any part of the system shall be checked for proper lubrication and any other condition which may cause damage to the equipment or endanger personnel.

H. After systems have been demonstrated to be satisfactory for 7 consecutive days and ready for permanent operation, all permanent pipe line strainers shall be cleaned, valve and packings properly adjusted, lubrication checked and replenished if required. Temporary piping, etc. shall be removed and openings restored in a permanent manner acceptable to the Owner's representative.

I. Conduct a walk-through instruction seminar for the Owner's personnel pertaining to the continued operation and maintenance of fire suppression equipment and systems. Explain the identification system, maintenance requirements, operational diagrams, temperature control provisions, sequencing requirements, security, safety, efficiency and similar features of the systems. Walk through must be documented as to those attending and subjects covered. Walk through document(s) shall be signed and dated by the contractor's representative and the owner's representative.

1. Training sessions shall be recorded by video camera by the contractor and the recording shall be turned over to the owner in DVD format.

J. At the time of substantial project completion, turn over the prime responsibility for operation of the fire suppression equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.

1. If any systems are operated prior to substantial completion, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

1.13 RECORD DOCUMENTS

A. Prepare as-built documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in above, indicate the following installed conditions:

1. The Fire Suppression Contractor shall provide the Owner with as-built drawings for pipe mains and branches, size and location, for both exterior and interior; locations of control valves and supervisory switches; drain valves; and indicate all devices requiring periodic maintenance or repair.
2. All fire suppression systems as described in the Specifications and/or shown on the drawings.
3. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located. Valve location diagrams, complete with valve tag chart. Refer to Division 21 Section "Fire Suppression Identification." Indicate actual inverts and horizontal locations of underground piping.

4. Equipment/material locations (exposed and concealed), dimensioned from prominent building lines.
5. All items must be dimensioned in horizontal and vertical plans to allow Architect/Engineer to update Building Information Model (BIM) file for Owner.

1.14 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

B. Provide electronic copies, preferably in Adobe Acrobat Portable Document Format (pdf), of all maintenance manuals to Temperature Control Contractor for use in EMCS front-end system. Provide data in file types compatible with EMCS.

2. PRODUCTS (NOT APPLICABLE).

3. EXECUTION

3.1 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Store and handle material and equipment in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

C. Use proper lifting equipment where size/weight requires handling by such means.

D. Comply with manufacturer's rigging and moving instructions for unloading material and equipment, and moving them to final location.

E. Equipment requiring disassembly for access purposes shall be disassembled and reassembled as required for movement into the final location following manufacturer's written instructions.

F. Deliver material and equipment as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

G. Fire Suppression Contractor shall schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site.

H. Any material that is damaged during delivery, storage, handling, or installation shall be brought to the attention of the Architect/Engineer for review of its acceptability in the project.

1. The Architect/Engineer shall be the sole and final judge as to the suitability of damaged items.

3.3 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.4 COORDINATION

A. Sequence, coordinate, and integrate installations of fire suppression materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

B. Coordinate the fire suppression work with work of the different trades so that:

1. Interferences between fire suppression, mechanical, electrical, architectural, and structural work, including existing services, will be avoided.

2. Within the limits indicated on the drawings, the maximum practicable space for operation, maintenance repair, removal and testing of fire suppression and other equipment will be provided.
3. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:

    a. Light fixtures.
    b. Gravity flow piping, including steam and condensate.
    c. Equipment requiring access, including terminal units, fire/smoke dampers, and piping valves.
    d. Ductwork.
    e. Electrical busduct.
    f. Electrical cable trays, including access space.
    g. Piping (hydronic and plumbing).
    h. Sprinkler/standpipe piping.
    i. Electrical conduits and wireway.

4. Pipes, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.

C. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.

D. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

3.5 FIRE SUPPRESSION INSTALLATIONS

A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.

B. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.

C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Architect/Engineer and the Owner's representative shall be notified and any changes approved before proceeding with the work.

D. Arrange for chases, slots, and openings in other building components during progress of construction to allow for fire suppression installations.

E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom.

F. Coordinate connection of fire suppression systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

G. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

I. Install fire suppression equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

K. Welding, sweating, or brazing operations

1. All cutting, welding, brazing, or sweating operations carried on in the vicinity of, or accessible to, combustible material shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.
2. When it is necessary to do cutting, welding, brazing, or sweating close to wood construction, in pipe shafts, or other locations where combustible materials cannot be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. Position another individual nearby to guard against sparks and fire.
3. Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations, or spatter from electric arc operations, a guard shall be kept at the place of work for at least one hour after completion to verify that smoldering fires have not been started.
4. Whenever welding or cutting operations are carried on in a vertical shaft or where floor openings exist, a fire guard shall be employed to examine all floors below the point of the welding or cutting operation. The fire guard shall be kept on duty for at least one hour after completion to verify that smoldering fires have not been started.
5. Before any work involving cutting, welding, brazing, or sweating operations is started, consult with the Architect/Engineer as to particular safety precautions to be employed on the work.

3.6 ACCESSIBILITY

A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.7 LUBRICATION AND TOOLS

A. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's representative prior to final acceptance of the equipment.

3.8 START-UP

A. PIPING SYSTEMS PRESSURE TESTING

1. The following personnel in the order listed shall be considered acceptable witnesses of all piping pressure testing:

   a. Local Authority Having Jurisdiction
   b. Owner's Representative
   c. Mechanical Engineer / Architect
   d. General Contractor's Foreman

2. Removal of pressure charge and associated drain down shall also be witnessed.
3. Fire suppression contractor shall provide a minimum of 24-hour notice to at least one of the above listed parties before commencing any piping systems pressure test.
4. Pressure gauge requirements: Provide recently calibrated gauge with 4" face and a range such that test pressure is between 50% and 100% of gauge range. For example, a gauge with a 15 psig range is acceptable for a 10 psig pressure test, whereas a gauge with a 30 psig range is unacceptable in this application. Gauge resolution shall be suitable for type of testing, system size and test media. Gauge shall have been recently calibrated.
5. All piping pressurizing equipment (i.e., air compressor) shall be disconnected before test is commenced and shall remain disconnected for the entire duration of the test.
6. Entire system shall be properly vented before test is commenced.
7. For specific piping pressure testing requirements and procedures, see applicable piping systems specification sections. At minimum, however, pipe systems should be tested at the following pressures and all installed components must be rated at this pressure at the actual operating temperature:

   a. Sprinkler and/or standpipe piping 200 psig

8. Submit completed "Pipe Pressure Test Log" provided at the end of this Section for each pressure test before final project closeout. Test log shall also be included in operation and maintenance manuals.

NOTE: USE MULTIPLE FORMS IF NECESSARY

3.9 GENERAL CONTRACTOR - FIRE SUPPRESSION EXTENT OF WORK

A. Access Panels

1. Furnish and install panels for access to all valves and flow switches and similar items where no other means of access, such as readily removable, sectional ceiling is shown or specified.
2. The plans indicate the location of all anticipated access panels. The Division 21 Contractor shall make every effort to locate all material and equipment requiring service and maintenance above accessible ceilings or utilize the indicated access panels. Material and equipment requiring service and maintenance that is shown above inaccessible ceilings shall be relocated to accessible or exposed areas whenever possible. When these items are located in exposed areas, the Division 21 Contractor is to verify with the Architect/Engineer that the installation will not affect the aesthetics of the building. However, when it is not possible to locate these items in accessible or exposed areas due to the configuration of the actual installation of the fire suppression and other trade systems or aesthetic reasons, additional access panels shall be provided. The contractor shall be equitably compensated for the additional access panels.
3. Refer to Section 08 31 13 – Access Doors and Panels for specific information on type and size of panels

B. Cutting and Patching

1. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
2. The Division 21 Contractor shall coordinate all cutting and patching of holes, in existing building and new construction which are required for the passage of fire suppression work.
3. Division 21 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all cutting and patching requirements. The Division 21 Contractor shall be liable for all associated costs of cutting and patching for fire suppression work upon failure to notify the General Contractor prior to bid submission.
4. Under no circumstances shall any structural members, load-bearing walls or footings be cut without first obtaining written permission from the Engineer.
5. Cut, channel, chase and core drill floors, walls, partitions, ceilings, and other surfaces necessary for fire suppression installations. Perform cutting by skilled mechanics of the trades involved.
6. Patching of concrete openings shall be filled with grout and finished smooth with the adjacent surface.
7. All below-grade openings for pipe shall be sealed with interlocking synthetic rubber line assembly, Link-Seal by Thunderline Corporation or equal.
8. **All penetrations through the walls, floor, or structure of laboratory spaces, laboratory support spaces, corridors or other areas in which relative pressurization relationships are important shall be sealed airtight. Refer to the drawings for additional information regarding rooms in which maintaining pressurization is important.**

9. Repair cut surfaces to match adjacent surfaces.
10. Perform cutting, fitting, and patching of fire suppression equipment and materials required to:

    a. Uncover work to provide for installation of ill-timed work.
    b. Remove and replace defective work.
    c. Remove and replace work not conforming to requirements of the Contract Documents.
    d. Remove samples of installed Work as specified for testing.
    e. Install equipment and materials in existing structures.
    f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Excavation and Backfilling

1. Division 21 Contractor shall perform all excavation and backfilling necessary to install the required fire suppression work. Coordinate the work with other excavating and backfilling work in the same area.
2. Except as indicated otherwise, comply with the applicable sections in Division 2 of these specifications, excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.
3. Trenching: Trench width shall be no more than required for shoring, bracing and performance of the work. All necessary shoring and bracing shall be installed to insure worker safety, proper installation of fire suppression work, and protection of adjacent structures. Provide all dewatering as required. Depth shall not exceed that required to achieve the specified depth of cover and overdig will be permitted for bedding material only. All trenches shall be open cut from the surface.
4. Bedding: All work shall be properly bedded whether on virgin soil or on granular bedding as specified. All granular bedding shall be laid on undisturbed soil. PVC and copper piping shall have a 4" crushed stone bed conforming to specification for granular material in Division 2. If rock is encountered, excavate to a point 4" below installed bottom elevation of piping and provide bedding as called for above.
5. Haunching: Haunching shall be brought up on both sides of the pipe for a distance of 1/3 the pipe diameter and shall be of the same material used for bedding.
6. Backfill: Backfilling shall not begin until installation has been tested for leaks.
7. Final Backfill shall be as follows:

    a. Outside Building Under Paved Areas: Granular material specified in Division 2.
    b. Outside Building and Not Under Paved Areas: Clean soil free of vegetable matter and foreign material or crushed limestone. In planted areas backfill to a point 6" below finished grade. Owner will provide topsoil to finished grade.

8. Placement: Place all granular material in lifts of 12" maximum compacted to 100% of maximum dry density as determined as ASTM D698. Place soil in 6" lifts compacted to 95% of maximum density as determined by ASTM D698. Do not place any backfill until excavations have been cleaned of all water, debris and loose or soft soil.

9. Protection: At least 72 hours prior to excavating, for each phase, Contractor shall contact the Owner's Representative to arrange for utility locates in the construction area.
10. Contractor shall provide temporary supports for all underground utilities crossing an excavation.
11. Provide all required barricades, fencing, signs, lights, etc. as necessary for the protection of the workers and of the general public.
12. Excess Material: All excess earth and other material resulting from the excavation shall be removed from site daily by the Contractor.
13. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Fire Suppression Contractor.

D. Concrete Bases

1. Minimum 4" high concrete housekeeping pads shall be provided under all floor-mounted fire suppression equipment, regardless of whether explicitly shown on the Drawings. Concrete inertia pads with spring isolators shall be provided for all base-mounted pumps and air compressors installed on any floors which are not slab-on-grade. Inertia pads and isolators shall be sized by the equipment manufacturer if specific information is not provided in the Contract Documents.
2. Division 21 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all fire suppression equipment bases. The Division 21 Contractor shall be liable for all associated costs to install the fire suppression equipment bases upon failure to notify the General Contractor prior to bid submission.
3. Construct concrete equipment bases a minimum 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive strength concrete, reinforcement and forms as specified in Division 3 Section "Cast-In-Place Concrete." Coordinate final equipment base size with General Contractor.
4. All equipment shall be mechanically fastened to concrete bases.

E. Roof curbs, roof support for fire suppression equipment and roof penetrations.

1. Verify, prior to submitting bid, the number, size, and location of all roof curb and roof supports and the location of all roof penetrations. Provide all roof deck-mounted equipment, pipe supports, and pipe penetrations. Cut roof deck for pipe and duct penetrations, unless noted otherwise. Provide all roof covering/membrane mounted equipment and pipe supports and roof drains, unless noted otherwise.
2. Contractor shall be liable for all associated costs to install the roof curbs, roof supports and roof penetrations not shown on the roof plan or added after the roof system has been installed. Coordinate with the General Contractor prior to construction the number size and location of all roof penetrations.
3. All roof curbs, supports, and rails shall be sized to keep equipment a minimum of 24” above the roof insulation membrane in order to limit snow accumulation at or near equipment.

F. Painting

1. The General Contractor is to field paint fire suppression equipment and materials in specified areas as noted on the fire suppression plans, fire suppression schedules and in the specifications. Division 21 Contractor is to coordinate the painting of these items with the General Contractor. The Fire Suppression Contractor is to provide materials in these areas that are suitable for accepting paint. The clean and preparation of the materials to reach paint is the responsibility of the General Contractor unless noted specifically to be responsibility of the Division 21 Contractor.
2. In concealed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted with one coat of zinc rich paint.
3. In exposed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted in accordance with Section 09 91 00.

3.10 ELECTRICAL-FIRE SUPPRESSION EXTENT OF WORK

A. The responsibility of work specified under Division 21 and 26 is clarified under Section 21 05 13, "Electrical Requirements for Fire Suppression Equipment. Division 21 Contractor is to coordinate all electrical requirements prior to ordering powered fire suppression equipment.

END OF SECTION 21 05 00

PIPE PRESSURE TEST LOG

PROJECT:

BUILDING:

GENERAL CONTRACTOR:

CLARK ENERSEN PROJECT NUMBER:

MECHANICAL CONTRACTOR:

TEST INFORMATION						TEST PRESSURE					
TEST DATE	PIPING SYSTEM	AREA TESTED	TEST MEDIA (WATER OR AIR)	TEST DURATION (MINUTES)	PRESSURE GAGE NUMBER	INITIAL (PSIG)	FINAL (PSIG)	TESTED BY	WITNESSED BY	PASS / FAIL (P/F)	COMMENTS

ADDITIONAL COMMENTS:

PRESSURE GAGE INFORMATION

GAGE NUMBER	MANUFACTURER	PRESSURE RANGE	RESOLUTION	STYLE	DIAL SIZE	GAGE NUMBER	MANUFACTURER	PRESSURE RANGE	RESOLUTION	STYLE	DIAL SIZE

NOTE: USE MULTIPLE FORMS IF NECESSARY

SECTION 21 05 13 - ELECTRICAL REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.2 SUMMARY

A. This section specifies the basic requirements for electrical components which are an integral part of packaged fire suppression equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged fire suppression equipment. In addition, this section covers necessary coordination issues between fire suppression and electrical disciplines. All fire suppression and electrical construction documents must be completely reviewed by the Fire Suppression and Electrical Contractors prior to the submission of bids. Any discrepancies in the documents should be brought to the Architect/Engineer's attention at that time. Failure to properly coordinate or review documents in advance of submission of bids will not be valid cause for changes to the overall Contract amount.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for fire suppression equipment are scheduled on the Drawings.

1.3 REFERENCES

A. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:

1. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.
2. NEMA Standard 250: Enclosures for Electrical Equipment.
3. NEMA Standard KS 1: Enclosed Switches.
4. National Electrical Code (NFPA 70).

1.4 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, or as required by the individual equipment specification sections.

1.5 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled and listed.

2. PRODUCTS

2.1 MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Minimum service factors shall be as follows:

Motor Service Factor Schedule		
Horsepower:	**3600 RPM:**	**1800 RPM:**
1/6 – 1/3	1.35	1.35
1/2	1.25	1.25
3/4	1.25	1.25
1 – 1.25	1.25	1.15
1.5 - 150	1.15	1.15

3. Two-speed poly-phase motors shall have two separate windings served by a single point electrical connection to the two speed starter. Two speed starters shall be located at the motor location unless otherwise noted.
4. Temperature Rating: Rated for 40 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
5. Starting capability: Frequency of starts as indicated by automatic control system, and not less than five (5) evenly timed starts per hour for manually controlled motors.
6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.

a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit each specific application.
b. Bearings: Ball or roller bearings with inner and outer shaft seals; regreasable; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.
c. Enclosure Type: Unless otherwise indicated, open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation; guarded

drip-proof motors where exposed to contact by employees or building occupants; weather protected Type I for outdoor use, Type II where not housed.

d. Overload protection: Built-in thermal overload protection (in accordance with NEC requirements) and, where indicated, an internal sensing device suitable for signaling and stopping the motor at the starter.

7. Noise rating: "Quiet"
8. Efficiency: "Premium efficiency" motors, as defined in NEMA MG 1, most recent edition.
9. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
10. Motors Used With Variable Frequency Drives: Ratings, characteristics, and features coordinated with and approved by drive manufacturer. Motor shall be designed and labeled for use with variable frequency drives. Motor shall be designed with critical vibration frequencies outside the operating range of the drive output and shall be suitable for use throughout speed range without overheating.

a. Provide AEGIS SGR, or approved equivalent, shaft grounding ring/system to divert adverse shaft currents away from the motor bearings. Use AEGIS Colloidal Silver Shaft Coating (PN CS015), or approved equivalent, prior to ring installation. Install coating and ring per manufacturer recommendations.

2.2 SHEAVES

A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.

B. When replacing sheaves, use sheaves of at least the originally supplied sizes.

C. Contractor shall be responsible for replacement sheaves required to achieve specified performance. Coordinate with testing and balancing of the equipment.

2.3 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor-Starter Characteristics: Motor starters shall be compatible with the equipment they serve. In general, motor starter characteristics shall meet the requirements of Division 26 specification sections

B. MOTOR CONNECTIONS

1. Provide connections to motors in accordance with the requirements listed in the electrical specifications.
2. See Division 26 for the use of lugs for motor connections.

2.4 SAFETY SWITCHES

A. Furnish and install heavy duty type safety switches, having the electrical characteristics, ratings and modifications shown on the drawings. All switches shall have:

1. NEMA 1 general purpose enclosures unless otherwise noted for all interior applications.
2. NEMA 3R rainproof enclosures unless otherwise noted for all exterior applications.
3. Metal nameplates, front cover mounted that contain a permanent record of switch type, catalog number and H.P. ratings with both standard and time delay fuses.
4. Handle that is padlockable in "OFF" position.
5. Non-teasible, positive quick-make, quick-break mechanism.
6. UL approval and shall bear the UL label.
7. All fusible switches shall have Class R Fuse rejection clips.

2.5 DIVISION-26 RESPONSIBILITY

A. Unless otherwise noted, furnish and install single phase starters with thermal overload protection for all single phase motors not indicated as part of the Division 21 responsibility. Furnish and install all full voltage, non-reversing, single speed motor starters for appropriate three phase equipment. Furnish and install disconnect switches for all three phase motors. Provide the following additional equipment as required.

B. Provide auxiliary motor starter contacts as shown on the drawings or as required for proper control of equipment.

C. Furnish and install all motor power circuit conduit and wiring.

D. Install power factor correction capacitors furnished by the Division 21 Contractor.

E. Furnish and install all junction boxes.

2.6 DIVISION-21 RESPONSIBILITY

A. Furnish and set all motors.

B. Furnish and install all electrical control circuit conduits and wiring and control devices required to perform the equipment control functions as specified in Division-21.

C. All electrical equipment provided, including the wiring and installation of electrical equipment shall be in strict accordance with the requirements of this Section and Division-26.

3. EXECUTION

3.1 INSTALLATION

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

3.2 CONTRACTOR COORDINATION

A. Unless otherwise indicated on drawings, all equipment, controls, etc. shall be furnished, set in place and wired in accordance with this specification section and the following schedule. Attached notes shall apply to schedule.

ITEM:	FURNISHED BY:	SET BY:	POWER WIRING BY:	TEMPERATURE CONTROL WIRING BY:
Fire suppression solenoid valves, supervisory switches, etc.	FPC	FPC	EC	--

SCHEDULE KEY: FPC = Fire Suppression Contractor
EC = Electrical Contractor

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 21 05 19 – FIRE SUPPRESSION GAUGES

1. GENERAL

1.1 SECTION INCLUDES

A. Pressure gauges and pressure gauge taps.

B. Piping pressure and temperature test plugs.

1.2 REFERENCE SECTION 21 05 00 FOR THE FOLLOWING:

A. REFERENCES

B. SUBMITTALS

C. PROJECT RECORD DOCUMENTS

1. Accurately record actual locations of instrumentation.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

2. PRODUCTS

2.1 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection, liquid-filled.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. Vacuum: 30 inches Hg to 15 psi.
2. All fluids: 2 times operating pressure.

2.2 PRESSURE GAUGE ACCESSORIES

A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.3 PIPING PRESSURE AND TEMPERATURE TEST PLUGS

A. Test Plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:

1. Air, Water, Oil, and Gas, 20 to 200 deg F: Neoprene.

3. EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions and NFPA 13 and NFPA 14 requirements.

3.2 PRESSURE GAUGES

A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most readable position.

B. Install as shown on plans, and elsewhere as indicated.

C. Pressure Gauge Ball Valves: Install in piping tee with snubber. Install syphon in lieu of snubber for steam pressure gages.

3.3 TEST PLUGS

A. Test Plugs: Install where indicated, located on pipe at most readable position. Secure cap.

3.4 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 21 05 29 – FIRE SUPPRESSION HANGERS AND SUPPORTS

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe and equipment hangers, supports, anchors, saddles and shields.

B. Sleeves and seals.

C. Mechanical sleeve seals.

D. Sealants, firestop insulation, putty and compounds.

1.2 REFERENCE SECTION 21 05 00 FOR THE FOLLOWING:

A. REFERENCES

1. NFPA 13, 14, and 24.
2. MSS SP-58 – Pipe Hangers and Supports – Materials, Design, and Manufacture.
3. MSS SP-69 – Pipe Hangers and Supports – Selection and Application.
4. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices.

B. SUBMITTALS

C. DELIVERY, STORAGE, AND HANDLING

2. PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Fire Suppression and Standpipe Piping:

1. Conform to International Fire Code, NFPA 13, NFPA 14, NFPA 24, MSS SP58, MSS SP69 and MSS SP89, as applicable.

B. Hangers and Supports:

1. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch, Carbon steel, adjustable swivel, band type.
2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

5. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
6. Vertical Support: Steel riser clamp.
7. Floor Support for Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.3 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Internally Threaded Screw Anchors: Internally threaded, self tapping screw anchors, Power Fasteners Snake or approved equivalent.

1. Tested in accordance with ACI 355.2 and ICC-ES AC193 for use in structural concrete under the design provisions of ACI318 (Strength Design method using Appendix D)

2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage galvanized steel.

C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

2.6 SEALANTS, FIRESTOP INSULATION, PUTTY, AND COMPOUNDS

A. Firestopping Insulation: Glass fiber type, non-combustible, UL listed.

B. Firestop Putty: Non-harding, non shrinking, UL listed.

C. Firestop Compounds: Cementitous material, non-shrinking, UL listed.

D. Sealants:

1. Non fire/smoke rated partitions: Acrylic or silicone based caulking.
2. Fire/smoke rated partitions: Silicone based caulking, UL listed.

2.7 MECHANICAL SEALS

A. Mechanical Seals: Modular mechanical type, consisting of interlocking EPDM synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with type 316 stainless steel bolts and reinforced plastic polymer pressure plates which cause rubber sealing elements to expand when tightened, providing a watertight and gas-tight seal and electrical insulation. Provide Advance Products & Systems Model Innerlynx or equivalent.

1. A sleeve shall be provided for each mechanical seal.

a. Thermoplastic sleeves: Sleeve shall have smooth walls and shall be made of molded non-metallic high density polyethylene (HDPE) with an integral solid water stop, Advance Products & Systems Model PWS or equivalent.
b. Steel sleeves: Sleeve shall have smooth walls, shall be made of Schedule 40 steel with an integral welded solid water stop, and shall have corrosion-resistant coating, Advance Products & Systems Model GWS or equivalent.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 13, 14, and 24.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Support fire suppression systems piping independently from other piping systems. Fire main piping may be trapezed with other piping systems. Coordinate trapeze hangers with the Division 21 Contractor and other trades.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for non-insulated copper pipe.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat steel hangers and supports in the mechanical room and other exposed areas. Refer to the Architectural reflected ceiling plans for location of exposed ceilings. Hangers and supports located in attic space, crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Adjust hangers to distribute loads equally on attachments and to achieve specified pipe slopes.

3.4 FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrate weather or waterproofed walls and floors.

B. Provide acoustical lead flashing around pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

3.5 SLEEVES

A. Provide pipe and duct sleeves at all fire/smoke rated partitions, exterior wall penetrations and wall penetrations into exposed areas. Pipe sleeves are not required for penetrations through non-rated concealed partitions.

B. At the Contractor's option, pipe sleeves may be omitted if the wall or floor is core drilled, except in areas potentially exposed to wet conditions (such as mechanical rooms, loading dock, generator room, penthouse, kitchen, etc.).

C. Set sleeves in position in formwork. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Sleeves through floors shall be grinded flush with finish floor level. In areas potentially exposed to wet conditions (such as mechanical rooms, loading dock, generator room, penthouse, kitchen, etc.), sleeve shall extend a minimum of 2" above finish floor.

F. Where piping penetrates non-rated ceilings or walls, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.

G. Seal pipe penetrations through non-rated floors.

1. Where piping is not located in a rated shaft and it penetrates a single non-rated floor, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.
2. Where piping is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between pipe and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.

H. Where piping penetrates rated floor, ceiling, or wall, close off space between pipe or duct with appropriate fire rated sealant, insulation, putty or compound. Refer to the Drawings for fire/smoke rated wall locations and the appropriate ratings.

I. Install chrome plated steel escutcheons on piping at finished surfaces.

J. Provide mechanical seals and sleeves through exterior wall and floor penetrations and 3 hour or higher fire rated partitions.

3.6 HANGER SCHEDULES

A. Reference International Fire Code, NFPA 13, and NFPA 14 where applicable.

END OF SECTION

SECTION 21 05 53 – FIRE SUPPRESSION IDENTIFICATION

1. GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe Markers.

D. Ceiling Tacks/Stickers.

1.2 REFERENCE SECTION 21 05 00 FOR THE FOLLOWING:

A. REFERENCES

B. RELATED SECTIONS

C. SUBMITTALS

D. QUALITY ASSURANCE

E. PROJECT RECORD DOCUMENTS

1. Record actual locations of tagged valves.

2. PRODUCTS

2.1 NAMEPLATES

A. Equipment Mark Nameplates: Laminated three-layer plastic with engraved black letters (matching equipment mark indicated on drawings) on light contrasting background color, with minimum 3/4 inch high letters.

B. Equipment Nameplates: Factory-applied permanent nameplate indicating the manufacturer's name, model, serial number, temperature and pressure design, and any other data necessary to conform with specified requirements. On equipment installed outdoors, nameplate shall be stamped steel or engrave plastic.

2.2 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.

B. Chart: Typewritten list that is plastic laminated and mounted in mechanical room. Valve list is to coordinate with mechanical piping schematics if provided on plans.

C. Pipe Schematics: Valve numbers are to be labeled on Engineer schematic drawings, plastic laminated and schematic shall be mounted in mechanical room.

2.3 PIPE MARKERS

A. Color: Conform to ASME A13.1.

B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed.

3. EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe in accordance with manufacturer's instructions. Directional arrow tape shall be overlapped to ensure proper adhesion and no peeling of tape in future.

D. Identify hose connections cabinets and drain termination points with plastic nameplates.

E. Identify tags on backflow preventers, drain valves, test connections, risers, alarm devices, and hose connections with tags. Label each valve as normally open or normally closed, as appropriate.

F. Identify valves in main and branch piping with tags.

G. Identify piping, concealed or exposed, with plastic tape pipe markers. For pipes ¾" and smaller, identify piping with tags. Identify service, flow direction, and pressure when applicable, i.e. low pressure steam, high pressure steam. Install in clear view from floor and align with axis of piping. Locate identification not to exceed 15 feet on straight runs including risers and drops, more often in congested areas, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Provide a minimum one label per pipe per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 21 13 13 - FIRE SUPPRESSION SYSTEM

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe, fittings, valves, and connections for an automatic wet-pipe sprinkler system.

B. System design, installation, and certification.

C. Water main connections.

1.2 REFERENCE SECTION 21 05 00 FOR THE FOLLOWING:

A. REFERENCES

1. NFPA 13 - Installation of Sprinkler Systems.
2. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances

B. PROJECT RECORD DOCUMENTS

1. Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

C. OPERATION AND MAINTENANCE DATA

D. DELIVERY, STORAGE, AND HANDLING

1. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.3 SYSTEM DESCRIPTION

A. System to provide coverage for the entire building to include overhangs as required by NFPA.

B. System shall be an automatic wet sprinkler system conforming to NFPA 13 Light Hazard, Ordinary Hazard – Group 1, and Ordinary Hazard – Group 2 occupancy requirements. See drawings for zoning requirements and additional information.

C. Determine volume and pressure of incoming water supply from water flow test data. Obtain water flow test data from Owner's Representative. See drawings for further information.

D. Interface system with building fire and smoke alarm system. Fire alarm specialties related to the sprinkler system (i.e. flow switches, supervisory valves, etc.) shall be provided and installed by the sprinkler contractor. However, these devices shall be wired under Division 26.

E. Although not specifically specified, the Contractor shall provide and install all supplementary and/or miscellaneous items and devices as required for a complete, code compliant and operational sprinkler system.

1.4 SUBMITTALS

A. **Note the following procedure for fire suppression submittals:**

B. Shop Drawings: Indicate hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories. Indicate system controls. Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

C. Product Data: Provide data on sprinkler heads, valves, and specialties, including manufacturer's catalogue information. Submit performance ratings rough-in details, weights, support requirements, and piping connections.

D. Submit shop drawings, product data, hydraulic calculations to Owner and Engineer for approval. After initial submittal has been reviewed by the Owner and Engineer and the review comments have been incorporated, submit all information to the authority having jurisdiction (local and state Fire Marshal) for approval. Coordinate submittal to authority having jurisdiction with the fire alarm shop drawing submittal. Submit proof of approval to Architect/Engineer.

1.5 QUALITY ASSURANCE

A. Designer and Installer: Company specializing in performing work of this Section with minimum three years experience.

B. Sprinkler Systems: Perform work to NFPA 13. Contractor shall hydraulically calculate system pipe sizes in accordance with NFPA 13. Calculations and design drawings shall be sealed by a licensed Professional Engineer registered in Missouri.

C. All grooved fittings, valves, and specialties shall be compatible with the specified coupling.

D. Equipment and Components: Bear UL and FM label or marking.

E. Valves: Bear UL and FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

1.6 REGULATORY REQUIREMENTS

A. Hydraulic Calculations, Product Data, Shop Drawings: Bear stamp of approval of authority having jurisdiction (including Fire Marshall if required); Shall be sealed by a licensed Professional Engineer registered in Missouri.

1.7 EXTRA MATERIALS

A. Furnish under provisions of appropriate Division 1 specification section.

B. Provide extra sprinklers and storage cabinets under provisions of NFPA 13.

C. Provide suitable wrenches for each head type.

2. PRODUCTS

2.1 SPRINKLER PIPING, BURIED

A. Ductile Iron Pipe: ASTM A377, AWWA C106, Class 150.

1. Fittings: AWWA C110, ductile iron, standard thickness.
2. Joints: Mechanical joints with ANSI/AWWA C111 rubber gasket.

2.2 SPRINKLER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53 or ASTM A795; Schedule 40 black steel.

1. Steel Fittings: ANSI/ASME B16.5, steel flanges and fittings.
2. Cast Iron Fittings: ANSI/ASME B16.4, screwed fittings.
3. Malleable Iron Fittings: ANSI/ASME B16.3, screwed type.
4. Joints: Flanged, grooved or threaded.
5. Mechanical Grooved Couplings: Victaulic Installation-Ready 107N and 009-EZ or 005 Firelock Rigid with rolled grooved fittings, no equivalent. Cut grooves or O-ring type socket fittings are not allowed.
6. Mechanical weld-o-lets and thread-o-lets are allowed.
7. Mechanical Tee fittings are not allowed unless approved by the Project Engineer.

B. Pipe hangers shall conform to NFPA standard 13 requirements and shall be FM/UL approved for use in fire sprinkler systems. Refer to specification section 21 05 29 for additional information.

C. Sprinkler piping in exposed animal holding areas shall be coated with epoxy paint for corrosion-resistance. Refer to 09 96 00 – High Performance Coatings.

2.3 FLEXIBLE SPRINKLER HOSE

A. Manufacturer: Victaulic, no equivalent.

B. Basic Use:

1. Flexible stainless-steel hose assemblies and a bracketing system that connect sprinkler heads to the branch lines. Each flexible hose assembly shall be provided with an open-gate mounting bracket and a 1-piece, leak tested sprinkler drop. The mounting bracket shall be compatible with application and allow installation before the ceiling tile is in place.
2. Flexible hose assembly shall be pressure/leak tested system available in 2' – 6' hose lengths.
3. Hose bend radius to 2" for AH2 or AH2-CC, and 3" for AH1.
4. All flexible hose assembly shall Factory Mutual (FM 1637) approved and UL 2443 listed and are manufactured in an FM/UL audited facility.
5. Zinc plated steel Male threaded nipple or Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping.
6. Compatible with any FM/UL approved sprinkler head.
7. 100% leak tested system.
8. Industrial grade, all welded, no O-ring construction, with all stainless steel components.
9. Adjustable height and sprinkler alignment / center-of-tile uniformity.
10. Rated up to 300 psi with no additional hangers required.
11. Approved for use in suspended ceiling systems with light, medium and heavy load grids (ASTM C635, C636)
12. True-bore 1" internal corrugated hose diameter, which produces friction loss values similar to hard pipe armovers.
13. IBC and SEI/ASCE 7-02 compliant for sprinklers installed in seismic design classes C and D/E/F.

C. Composition and Materials:

1. Every flexible hose assembly shall come complete with the flexible hose. Each connection shall be made from 100% factory tested Type 304 stainless steel. The hose nipples shall be 304 stainless steel and be fully welded. Flexible hose assembly shall be leak tested to 175 psi. Hose factory tested to 400 psi (2760 kPa.
2. The bracket system shall be factory or shop fabricated made from galvanized sheet metal and is approved and compatible for application. Coordinate with flexible hose manufacturer.

D. Flexible fire sprinkler hose is not allowed for use in an exposed ceiling, all areas that are visible shall be hard piped.

E. Basis of Design: Victaulic Vic-Flex.

2.4 GATE VALVES

A. Up to and including 2 Inches: Bronze body, bronze trim, non-rising stem, handwheel, inside screw, solid wedge disc, threaded ends, class 175, UL/FM approved.

B. Over 2 Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, solid wedge disk, flanged or grooved ends, class 175, UL/FM approved.

2.5 ANGLE VALVES

A. Up to 2 Inches: Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable composition disc, screwed ends, with backseating capacity, class 175, UL/FM approved.

B. Over 2 Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc, class 175, UL/FM approved.

2.6 BALL VALVES

A. Up to and including 2 Inches:

1. Bronze two piece body, stainless steel ball, Teflon seats and stuffing box ring, lever handle threaded ends, blowout proof stem, full port, 600 WOG, UL/FM approved.

2.7 BUTTERFLY VALVES

A. Cast or ductile iron body, aluminum bronze disc, resilient replaceable EPDM seat, grooved, wafer, or lug ends, extended neck handwheel and gear drive and integral indicating device and built-in tamper proof switches, 300-psi rated, UL/FM approved.

2.8 CHECK VALVES

A. Up to and including 2 Inches: Bronze swing disc, screwed ends, class 200, UL/FM approved.

B. Over 2 Inches: Iron body, stainless steel or bronze trim, spring-assisted swing disc for vertical or horizontal installation, renewable disc and seat, flanged, screwed or grooved ends, UL/FM approved.

2.9 SPRINKLER SYSTEM CONTROL VALVES

A. Cast- or ductile-iron body, flanged or grooved ends, 225 psig minimum pressure rating, UL/FM approved.

2.10 DRAIN VALVES

A. Brass ball valve with cap and chain, 3/4 inch hose thread, UL/FM approved.

2.11 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate electrically operated alarms, with pressure retard chamber and variable pressure trim. Valve internal components shall be replaceable with valve in the installed position.

B. Water Flow Switch: Electrically supervised vane type switch for mounting horizontal or vertical, with two contacts.

C. Curb stops: Bronze body, ground key plug or ball, wide tee head with inlet and outlet to match service piping. Conform to all local water department requirements.

1. Service box for curb stop: Cast iron box with telescoping top section as required for valve bury depth. Include cover with lettering "WATER," and bottom section with base of size to fit over curb stop and barrel. Conform to all local water department requirements.

D. Tapping sleeve and valve: Complete assembly, including two piece cast iron bolted sleeve with outlet connections suitable for use with size and type of piping being connected.

2.12 FLOW ALARM SWITCHES

A. FM/UL approved, water flow switches which will close contact when flow is detected.

2.13 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Sprinklers shall be glass bulb type, with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. (Wrenches shall be provided by the sprinkler manufacturer that directly engage the cast wrench boss.)

B. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.
2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
3. High or *intermediate* temperature *sprinklers* heads shall be provided in all mechanical rooms, elevator equipment rooms, and emergency generator rooms, attics and elsewhere when elevated ambient temperatures might be expected.

C. Sprinkler Finishes:

1. PTFE (corrosion resistant) in animal areas.

D. Retain special coatings in first paragraph below that are indicated in "Sprinkler Schedule" Article.

E. Special Coatings:

1. Wax.
2. Lead.
3. Corrosion-resistant paint.

F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Install concealed sprinkler heads in all corridors. Install semi-recessed sprinkler heads in all other spaces with dropped ceilings. Install upright sprinkler heads in all areas without ceilings.

1. Ceiling Mounting: PTFE-coated steel, one piece, flat.
2. Sidewall Mounting: PTFE-coated steel one piece, flat.

A. Sprinkler Guards:

1. Provide sprinkler head guards in mechanical rooms, high traffic areas and areas where heads are lower than 10'- 0" above the finished floor and/or where heads may be vandalized.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

G. Escutcheons and guards shall be listed, and supplied for use with the sprinkler by the sprinkler manufacturer.

2.14 VALVE SUPERVISORY SWITCHES

A. Standard: UL 346

B. Type: Electrically supervised

C. Components: Single-pole, double-throw switch with normally closed contacts.

D. Design: Signals that controlled valve is in other than fully open position.

2.15 HOSE CONNECTIONS

A. Connection: UL 668, brass or bronze, 300 psig minimum pressure rating, NPS 2-1/2 hose valve compatible with local fire department requirements, with lugged cap, gasket, and chain. Provide chrome-plated finish.

B. Cabinet: Recessed mounting, 18”x18”x8” fire-rated enclosure, solid panel door with continuous steel piano hinge, white baked acrylic enamel finish, type 304 stainless steel, door and frame materials, with appropriate labeling.

3. EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel, thread or groove plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as disconnect points if required.)

3.2 INSTALLATION

A. Install piping in accordance with NFPA 13 and NFPA 24 as applicable.

1. Grooved Joints: Install in accordance with the manufacturer’s latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service. Contractor shall remove and replace any improperly installed products.

B. Provide thrust blocks for each change of direction in underground fire service pipe in accordance with NFPA 24.

C. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient. Place pipe runs to minimize obstruction to other work.

D. Install piping to conserve building space, and not interfere with use of space and other work. It shall be the primary responsibility of sprinkler contractor to coordinate with other building trades to avoid architectural, structural, mechanical and electrical interference’s. All necessary additional sprinklers, piping, and other equipment required to avoid such interferences shall be provided as part of the sprinkler contract without additional compensation after the bid is submitted. However, should a change be made in the work of other contractors or trades from that shown on the drawings which results in additional work for the sprinkler contractor, a reasonable and equitable adjustment in the contract sum may be made.

E. Sprinkler locations shown on drawings are recommendations only. Sprinkler design engineer shall verify and modify locations as necessary to provide a code-compliant, functional system. Sprinkler locations will be subject to review of the Owner and Architect/Engineer during the shop drawing review phase.

F. Wherever possible, install piping as high as possible so as not to interfere with the work of others. Wherever possible, place piping in concealed spaces above finished ceilings.

G. Group piping whenever practical at common elevations.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Slope piping and arrange systems to drain at low points.

I. If it is discovered during installation that any component of the sprinkler system will be exposed to freezing conditions, the contractor shall notify the Architect/Engineer immediately.

J. Prepare all exposed pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Paint to match finish of adjacent walls surfaces.

K. Do not penetrate building structural members unless specifically indicated.

L. Provide sleeves when penetrating footings, fire rated floors and fire rated walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.

M. Die cut screw joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

N. Install valves with stems upright or horizontal, not inverted.

O. Provide gate, ball or butterfly valves for shut-off or isolating service.

P. Provide drain valves at main shut-off valves, low points of piping and apparatus.

Q. Pipe main system drain valve and test connection to location outside building. See drawings.

R. Install equipment in accordance with manufacturer's instructions.

S. Install buried shut-off valves in valve box. Provide post indicator.

T. Provide backflow preventer as shown on drawings.

U. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent fire department connections to allow full swing of fire department wrench handle.

V. Install outside alarm gong on building wall in location coordinated with the Architect / Engineer.

W. All sprinklers installed in lay-in ceiling tiles shall be centered within the individual ceiling tile. Contractor shall provide all swing joints and/or offsets required to accomplish center locations. Ensure sprinklers are installed level with adjacent ceiling surface.

1. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

2. Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.

X. Apply masking tape or paper cover to ensure concealed sprinkler head cover plates do not receive field paint finish.

Y. Flush entire piping system of foreign matter.

Z. Install pressure gauge on riser or feed main and at each sprinkler test connection.

AA. Install sprinkler storage cabinet in first floor mechanical room. Coordinate location with other trades.

BB. Install all valves, flow switches, and other accessories in accessible locations. Where these components are located in a concealed area, provide access panels.

CC. Sprinkler piping shall not be installed above any electrical panels, electrical transformers, fire alarm panels, or EMCS panels, regardless of distance above.

3.3 FIELD QUALITY CONTROL

A. Hydrostatically test entire system per NFPA 13. Test shall be witnessed by authority having jurisdiction.

B. Perform a system test with a fire department pumper truck to verify acceptable pressure (typically 100 psig). Connect pumper truck to fire department connection for test. Coordinate with authority having jurisdiction and local fire department.

C. Note each test in Pipe Pressure Test Log provided in section 21 05 00 of these specifications. Submit test log to Engineer for review before final project closeout. Furnish copy of test log with operation and maintenance data.

D. The contractor shall furnish and sign copy of Contractor's Material and Test Certificate as provided in NFPA, Section 8-1 (Figure 8-1). Submit certificate to Engineer for review before final project closeout. Furnish copy of certificate with operation and maintenance data.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 05 00
BASIC PLUMBING REQUIREMENTS

1. GENERAL

1.1 SECTION INCLUDES

A. This section describes Basic Mechanical Requirements required to provide for a complete installation of all mechanical systems for this project. This section shall apply to all other Division 22 specification sections as well as all work shown on the drawings.

B. It is the intent of the Mechanical Division of the Specifications that all mechanical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations operate as designed.

C. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's representative.

D. The Contractor shall note that, in some cases, piping as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference-free systems with proper clearance to facilities and equipment.

E. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.

F. Note that the words "mechanical" and "plumbing" are used interchangeably throughout the Division 22 and 23 specification sections.

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section and all other sections of Division 22.

1.3 DESCRIPTION OF WORK

A. The work included under this section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete mechanical systems required by these specifications and/or shown on the drawings of the contract.

B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, piping fixtures, etc. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.

C. All plumbing work shall comply with International Plumbing Code.

1.4 QUESTIONS OF INTERPRETATION

A. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Architect/Engineer for clarification. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date. Verbal interpretation or explanation not issued in the form of an addendum shall not be considered part of the bidding documents. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.

B. The Architect/Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.5 CONTRACT DOCUMENT DISCREPANCIES

A. If any ambiguities should appear in the contract documents, the Contractor shall request clarification from the Architect/Engineer before proceeding with the work. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Architect/Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Architect/Engineer was requested and obtained before submission of bid.

B. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of three-dimensional objects. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies should be identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

C. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of materials or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.

D. If there is a conflict between manufacturer's recommendations and the Contract Documents, the manufacturer's recommendations shall govern with no additional cost to the Owner.

1.6 PERMITS

A. All permits, fees, licenses, etc. required for this project shall be obtained by the Contractor.

1.7 QUALITY ASSURANCE

A. Installers shall have at least 2 years of successful installation experience on projects with mechanical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation, unless noted otherwise in other mechanical sections.

B. Manufacturer of equipment and materials must be regularly engaged in the manufacture of the specified equipment and material with similar construction and capacities and whose products have been in satisfactory use in similar service for not less than five (5) years, unless noted otherwise in other Mechanical Sections.

C. Qualify welding processes and operators for structural steel according to AWS D1.1. "Structural Welding Code - Steel.

D. Quality welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Comply with provisions of ASME B31 Series "Code for Pressure Piping", including all addenda.

F. Contractor signed welder certificate(s) shall be submitted. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current. A record shall be maintained on the job site showing the date and results of qualification tests for each welder employed on the job. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner's representative.

G. For all the refrigerant work/service required by this project, all refrigerant technicians shall be EPA/ASHRAE 34 certified for corresponding classification type I, II, III and/or IV.

1.8 REFERENCES

A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following as applicable:

1. Safety and Health Regulations for Construction.

2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
3. ABMA - American Boiler Manufacturers Association.
4. ACCA - Air Conditioning Contractors of America.
5. ACGIH - American Conference of Governmental Industrial Hygienists.
6. ADC - Air Diffusion Council.
7. AGA - American Gas Association.
8. AIHA - American Industrial Hygiene Association.
9. AMCA - Air Movement and Control Association.
10. ANSI - American National Standards Institute.
11. ARI - Air-Conditioning and Refrigeration Institute.
12. ASA - Acoustical Society of American.
13. ASHRAE - American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
14. ASME - The American Society of Mechanical Engineers.
15. ASTM - American Society of Testing and Materials.
16. BOCA – Building Officials and Code Administrators International.
17. CABO – Council of American Building Officials.
18. CAGI - Compressed Air and Gas Institute.
19. CTI - Cooling Tower Institute.
20. EJMA - Expansion Joint Manufacturers Association.
21. ETL - Engineering Tests Laboratory.
22. HEI - Heat Exchange Institute.
23. HI - Hydraulic Institute.
24. HYD I - Hydronics Institute.
25. IAPMO – International Association of Plumbing and Mechanical Officials.
26. ICBO - International Conference of Building Officials.
27. ICC – International Code Council.
28. NEBB - National Environmental Balancing Bureau.
29. NEC - National Electrical Code.
30. NEMA - National Electrical Manufacturers Association.
31. NFPA - National Fire Protection Association.
32. NSF - National Sanitation Foundation.
33. SAE - Society of Automatic Engineers.
34. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
35. TEMA - Tubular Exchanger Manufacturers Association.
36. UL - Underwriters Laboratories, Inc.
37. International Plumbing Code.
38. International Mechanical Code.
39. Other governing, state, and local codes that apply.

1.9 SUBMITTALS

A. General: Follow the procedures specified in Division 1 Sections "General Conditions" and “Special Conditions”.

B. Shop drawings shall include the minimum following information as applies. Additional specific information required is outlined in other Mechanical Sections.

1. Certified performance and data with system operating conditions indicated. All coil, fan, and pump performance data shall be computer generated.
2. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicating, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
3. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, and methods of assembly of components.
4. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to electrical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
5. Maintenance Data: Submit maintenance data and parts list for each mechanical equipment, control and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

C. Coordination drawings

1. Drawings:

a. Provide coordination in determining adequate clearance and space requirements for fire suppression equipment, mechanical equipment, electrical equipment, and other items/equipment in the project. The Architect/Engineer reserves the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades. The Architect/Engineer will only review conflicts and give an opinion but will not perform as a coordinator.

b. Provide coordination drawings indicating structural components, reflected ceiling layout, fire suppression items, mechanical items, electrical items, and other systems. Indicate on the coordination drawings where components will be installed and how the service access area to such items shall be maintained. Illustrate items requiring access for maintenance or adjustment.

c. The Contractor will not be allowed any time extensions for participation in the coordination drawing process. The Contractor will not be allowed any contract cost extra for any additional fittings, rerouting or changes of duct size to equivalent sizes to those shown on the drawings that may be determined necessary through the coordination drawing process.

d. Deviations from the contract documents that are necessary for overall system installation and coordination shall be brought to the attention of the Architect/Engineer. Such necessary changes in the contract scope discovered through the coordination drawing process will be covered by the requirements of the "change order" process.

e. Access panels shall occur only in gypsum wallboard or plaster ceilings where indicated on the drawings or as needed to provide access to equipment, dampers, or valves. Access to fire suppression and other items shall be through accessible acoustical ceiling areas. Additional access panels will not be allowed without written approval from the Architect/Engineer at the coordination drawing stage and only after alternatives are reviewed. Layout changes shall be made to avoid additional access panels. If additional access panels are required, they shall be provided at no additional cost to the Owner.

f. Soffit penetrations and light alcoves shall be fully coordinated with hanging devices, studs, fire/smoke ratings, and structural support requirements.

2. The Contractor and subcontractors responsible for items of work located in or above ceilings shall participate in the coordination drawing process. Participation is mandatory. If the Contractor or subcontractor fails to participate in the coordination drawing process, the Owner reserves the right to do the following:

a. Stop construction progress payments for work performed by the Contractor. Payments will be reinstated only after the Contractor or subcontractor resumes participation in the coordination drawing process.

b. Require the relocation and resizing of components as necessary to ensure components will be installed as intended. In the event the Contractor did not participate in the coordination process, the Contractor will not be entitled to contract cost increases or time extensions due to Owner-initiated changes in the work.

c. The Contractor shall be held responsible for unnecessary rework that is attributable to failure to participate in the coordination process.

3. Drawings shall be prepared at 1/4 inch = 1 foot, 0 inches (minimum).

a. Coordination participants shall provide equipment installation and clearance requirements. This information shall be indicated on the coordination drawings.

b. Coordination drawings shall indicate the following major system components (including insulation, hub or connection widths with verification of turning radius):

1) Roof drain leaders
2) Large waste piping
3) Sprinkler mains
4) Equipment located above the ceiling
5) Heating hot water piping
6) Chilled water piping
7) Conduit runs 2 inches and larger
8) Cable tray
9) Bus duct

10) **Recessed light fixtures**
11) **Building wiring or cable trays**
12) **Ceiling heights as shown in contract documents and thickness of system**
13) **Soffits (including framing of supports)**
14) **Access points and clearances required**
15) **Access panels**
16) **Valves**
17) **Dampers**
18) **Coils**
19) **Ductwork**
20) **Fire-rated wall, partition, and floor penetrations**
21) **Steam and condensate piping**
22) **Space allotted for future utilities**
23) **Equipment in mechanical and electrical spaces**

c. **Information shall be delineated to indicate distances from column centerlines, pipe/equipment size, and distance from finished floor to bottom of pipe/equipment and hangers.**

4. **The coordination drawings shall be submitted to the Architect/Engineer and Owner's representative for review. The submitted coordination drawings shall indicate which contractors participated in the process and where conflicts appear to occur even after the priority ranking of utility routing has been utilized. In the event that conflicts require input from the Architect/Engineer, recommended solutions will be provided with the coordination drawings for review by the Architect/Engineer. The Architect/Engineer will review and return an opinion to the contractors for implementation. All contractors shall agree to the final coordinated layout by signing off on the coordination drawings before any construction can begin.**
5. **Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Architect/Engineer and the Owner for review on a monthly basis with changes "clouded" and brought to the attention of the Architect/Engineer and the Owner.**
6. **When a change order request is issued, the affected subcontractors shall review the coordination drawings and bring to the attention of the Contractor and the Architect/Engineer revisions necessary to the work of others not directly affected by the change order.**
7. **Contractors that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through accessible ceilings. Conflicts that result after the coordination drawings are signed off will be the responsibility of the Contractor or subcontractor who did not properly identify their work or installed the work improperly.**

1.10 SUBSTITUTES

A. All proposals shall be based on providing and installing the materials or items of equipment which are hereinafter specified.

B. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing. Associated mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are to be increased accordingly, but all recommended manufacturer clearances, etc., are to be maintained within the allotted mechanical spaces. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

C. Where the terms "or equivalent" is used, the Contractor may substitute alternate equipment, materials, etc. subject to review by the Architect/Engineer and the Owner's representative during the submittal phase of the project.

D. Where the term "or approved equivalent" is used, the Contractor may not substitute alternate equipment, materials, etc. unless requesting approval at least ten (10) days before the bid date. Notifications of any such approvals by the Architect/Engineer shall only be made in writing by Addendum.

E. Where the term "no equivalent" is used, the Contractor must provide the specified or scheduled equipment, materials, etc.

F. Final determination regarding substitutions shall be by the Architect/Engineer.

1.11 WARRANTY

A. Refer to the General Conditions section of this Specification for general warranty requirements and information. Additional warranty requirements are specified in subsequent Mechanical Sections.

1.12 CLOSE OUT AND OPERATION INSTRUCTIONS

A. Operate each system and item of equipment in a test run of appropriate duration, but no less than 7 days, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.

B. Any system placed in temporary operation for testing or for the convenience of the Contractor during construction shall be properly maintained and operated by the Contractor.

C. All systems shall be protected against freezing, flooding, corrosion or other forms of damage prior to acceptance by the Owner.

D. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced to the satisfaction of the Owner's representative.

E. All tests shall be made after notification to and in the presence of the Owner's representative.

F. Before starting up any system, each piece of equipment comprising any part of the system shall be checked for proper lubrication and any other condition which may cause damage to the equipment or endanger personnel.

G. After systems have been demonstrated to be satisfactory for 7 consecutive days and ready for permanent operation, all permanent pipe line strainers shall be cleaned, valve and packings properly adjusted, lubrication checked and replenished if required. Temporary piping, etc. shall be removed and openings restored in a permanent manner acceptable to the Owner's representative.

H. Conduct a walk-through instruction seminar for the Owner's personnel pertaining to the continued operation and maintenance of mechanical equipment and systems. Explain the identification system, maintenance requirements, operational diagrams, temperature control provisions, sequencing requirements, security, safety, efficiency and similar features of the systems. Walk through must be documented as to those attending and subjects covered. Walk through document(s) shall be signed and dated by the contractor's representative and the owner's representative.

1. Provide instruction seminar, minimum 4 hours each, for each of the following items: Water Purification System WPS-1, Domestic Water Heater DWH-1, and Laboratory Water Heater LWH-1.

I. At the time of substantial project completion, turn over the prime responsibility for operation of the plumbing equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.

1. If any systems are operated prior to substantial completion, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

1.13 RECORD DOCUMENTS

A. Prepare as-built documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in above, indicate the following installed conditions:

1. The Plumbing Contractor shall provide the Owner with as-built drawings for ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units and indicate all devices requiring periodic maintenance or repair, such as control power transformers, LACS panels/routers, field controllers, duct static pressure sensors, piping pressure sensors, etc.
2. All plumbing systems as described in the Specifications and/or shown on the drawings.
3. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 22 Section "Plumbing Identification." Indicate actual inverts and horizontal locations of underground piping.
4. Equipment/material locations (exposed and concealed), dimensioned from prominent building lines.
5. All items must be dimensioned in horizontal and vertical plans to allow Architect/Engineer to update Building Information Model (BIM) file for Owner.

1.14 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

B. Provide electronic copies, preferably in Adobe Acrobat Portable Document Format (pdf), of all maintenance manuals to Temperature Control Contractor for use in EMCS front-end system. Provide data in file types compatible with EMCS.

2. PRODUCTS (NOT APPLICABLE).

3. EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Store and handle material and equipment in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

C. Use proper lifting equipment where size/weight requires handling by such means.

D. Comply with manufacturer's rigging and moving instructions for unloading material and equipment, and moving them to final location.

E. Equipment requiring disassembly for access purposes shall be disassembled and reassembled as required for movement into the final location following manufacturer's written instructions.

F. Deliver material and equipment as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

G. Plumbing Contractor shall schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site.

3.2 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.3 COORDINATION

A. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

B. Coordinate the plumbing work with work of the different trades so that:

1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
2. Within the limits indicated on the drawings, the maximum practicable space for operation, maintenance repair, removal and testing of mechanical and other equipment will be provided.
3. Pipes, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.

C. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.

D. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

3.4 PLUMBING INSTALLATIONS

A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.

B. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.

C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Architect/Engineer and the Owner's representative shall be notified and any changes approved before proceeding with the work.

D. Arrange for chases, slots, and openings in other building components during progress of construction to allow for mechanical installations.

E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom.

F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

G. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

I. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

K. Welding, sweating, or brazing operations

1. All cutting, welding, brazing, or sweating operations carried on in the vicinity of, or accessible to, combustible material shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.
2. When it is necessary to do cutting, welding, brazing, or sweating close to wood construction, in pipe shafts, or other locations where combustible materials can not be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. Position another individual nearby to guard against sparks and fire.
3. Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations, or spatter from electric arc operations, a guard shall be kept at the place of work for at least one hour after completion to verify that smoldering fires have not been started.
4. Whenever welding or cutting operations are carried on in a vertical shaft or where floor openings exist, a fire guard shall be employed to examine all floors below the point of the welding or cutting operation. The fire guard shall be kept on duty for at least one hour after completion to verify that smoldering fires have not been started.
5. Before any work involving cutting, welding, brazing, or sweating operations is started, consult with the Architect/Engineer as to particular safety precautions to be employed on the work.

3.5 ACCESSIBILITY

A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.6 LUBRICATION AND TOOLS

A. Provide a fresh charge of lubricant in accordance with manufacturer's recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by Owner.

B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's representative prior to final acceptance of the equipment.

3.7 PIPING SYSTEMS PRESSURE TESTING

A. The following personnel in the order listed shall be considered acceptable witnesses of all piping pressure testing:

1. Local Authority Having Jurisdiction
2. Owner's Representative
3. Mechanical Engineer / Architect
4. General Contractor's Foreman

B. Removal of pressure charge and associated drain down shall also be witnessed.

C. Mechanical contractor shall provide a minimum of 24-hour notice to at least one of the above listed parties before commencing any piping systems pressure test.

D. Pressure gauge requirements: Provide recently calibrated gauge with 4" face and a range such that test pressure is between 50% and 100% of gauge range. For example, a gauge with a 15 psig range is acceptable for a 10 psig pressure test, whereas a gauge with a 30 psig range is unacceptable in this application. Gauge resolution shall be suitable for type of testing, system size and test media. Gauge shall have been recently calibrated.

E. All piping pressurizing equipment (i.e., air compressor) shall be disconnected before test is commenced and shall remain disconnected for the entire duration of the test.

F. Entire system shall be properly vented before test is commenced.

G. For specific piping pressure testing requirements and procedures, see applicable piping systems specification sections.

H. Submit completed "Pipe Pressure Test Log" provided at the end of this Section for each pressure test before final project closeout. Test log shall also be included in operation and maintenance manuals.

NOTE: USE MULTIPLE FORMS IF NECESSARY

3.8 GENERAL CONTRACTOR - MECHANICAL EXTENT OF WORK

A. Access Panels

1. Furnish and install panels for access to valves and dampers and similar items where no other means of access, such as readily removable, sectional ceiling is shown or specified.
2. The plans indicate the location of all anticipated access panels. The Division 22 Contractor shall make every effort to locate all material and equipment requiring service and maintenance above accessible ceilings or utilize the indicated access panels. Material and equipment requiring service and maintenance that is shown above inaccessible ceilings shall be relocated to accessible or exposed areas whenever possible. When these items are located in exposed areas, the Division 22 Contractor is to verify with the Architect/Engineer that the installation will not affect the aesthetics of the building. However, when it is not possible to locate these items in accessible or exposed areas due to the configuration of the actual installation of the mechanical and other trade systems or aesthetic reasons, additional access panels shall be provided. The contractor shall be equitably compensated for the additional access panels.

3. Refer to Section 08 31 13 – Access Doors and Panels for specific information on type and size of panels

B. Cutting and Patching

1. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
2. The Division 22 Contractor shall coordinate all cutting and patching of holes, in existing building and new construction which are required for the passage of mechanical work.
3. Division 22 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all cutting and patching requirements. The Division 22 Contractor shall be liable for all associated costs of cutting and patching for mechanical work upon failure to notify the General Contractor prior to bid submission.
4. Under no circumstances shall any structural members, load-bearing walls or footings be cut without first obtaining written permission from the Engineer.
5. Cut, channel, chase and core drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
6. Patching of concrete openings shall be filled with grout and finished smooth with the adjacent surface.
7. All below-grade openings for pipe shall be sealed with interlocking synthetic rubber line assembly, Link-Seal by Thunderline Corporation or equal.
8. **All penetrations through the walls, floor, or structure of laboratory spaces, laboratory support spaces, lecture halls, classrooms, conference rooms, corridors or other areas in which relative pressurization relationships are important shall be sealed airtight. Refer to the drawings for additional information regarding rooms in which maintaining pressurization is important.**
9. Repair cut surfaces to match adjacent surfaces.
10. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

    a. Uncover work to provide for installation of ill-timed work.
    b. Remove and replace defective work.
    c. Remove and replace work not conforming to requirements of the Contract Documents.
    d. Remove samples of installed Work as specified for testing.
    e. Install equipment and materials in existing structures.
    f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Excavation and Backfilling

1. Division 22 Contractor shall perform all excavation and backfilling necessary to install the required mechanical work. Coordinate the work with other excavating and backfilling work in the same area.

2. Except as indicated otherwise, comply with the applicable sections in Division 2 of these specifications, excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.
3. Trenching: Trench width shall be no more than required for shoring, bracing and performance of the work. All necessary shoring and bracing shall be installed to insure worker safety, proper installation of mechanical work, and protection of adjacent structures. Provide all dewatering as required. Depth shall not exceed that required to achieve the specified depth of cover and overdig will be permitted for bedding material only. All trenches shall be open cut from the surface.
4. Bedding: All work shall be properly bedded whether on virgin soil or on granular bedding as specified. All granular bedding shall be laid on undisturbed soil. PVC and copper piping shall have a 4" crushed stone bed conforming to specification for granular material in Division 2. If rock is encountered, excavate to a point 4" below installed bottom elevation of piping and provide bedding as called for above.
5. Haunching: Haunching shall be brought up on both sides of the pipe for a distance of 1/3 the pipe diameter and shall be of the same material used for bedding.
6. Backfill: Backfilling shall not begin until installation has been tested for leaks.
7. Final Backfill shall be as follows:

    a. Outside Building Under Paved Areas: Granular material specified in Division 2.
    b. Outside Building and Not Under Paved Areas: Clean soil free of vegetable matter and foreign material or crushed limestone. In planted areas backfill to a point 6" below finished grade. Owner will provide topsoil to finished grade.

8. Placement: Place all granular material in lifts of 12" maximum compacted to 100% of maximum dry density as determined as ASTM D698. Place soil in 6" lifts compacted to 95% of maximum density as determined by ASTM D698. Do not place any backfill until excavations have been cleaned of all water, debris and loose or soft soil.
9. Protection: At least 72 hours prior to excavating, for each phase, Contractor shall contact the Owner's Representative to arrange for utility locates in the construction area.
10. Contractor shall provide temporary supports for all underground utilities crossing an excavation.
11. Provide all required barricades, fencing, signs, lights, etc. as necessary for the protection of the workers and of the general public.
12. Excess Material: All excess earth and other material resulting from the excavation shall be removed from site daily by the Contractor.
13. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Mechanical Contractor.

D. Concrete Bases

1. Minimum 4" high concrete housekeeping pads shall be provided under floor mounted mechanical equipment. Concrete inertia pads shall be provided for all base-mounted pumps and air compressors installed in the penthouse area.

2. Division 22 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all mechanical equipment bases. The Division 22 Contractor shall be liable for all associated costs to install the mechanical equipment bases upon failure to notify the General Contractor prior to bid submission.
3. Construct concrete equipment bases a minimum 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive strength concrete, reinforcement and forms as specified in Division 3 Section "Cast-In-Place Concrete." Coordinate final equipment base size with General Contractor.

E. Roof curbs, roof support for mechanical equipment and roof penetrations.

1. Division 22 Contractor is to coordinate with the General Contractor all roof curb and roof supports supplied, number, size and location of all roof penetrations. All major roof penetrations are shown on the architectural roof plan. General Contractor shall be notified of all additional roof penetrations provided by the Division 22 Contractor not shown on this plan. The General Contractor shall provide all roof deck mounted equipment and pipe supports, pipe penetrations and cut roof deck for pipe and duct penetrations, unless noted otherwise. The Division 22 Contractor shall furnish all roof curbs and the General Contractor shall install, unless noted otherwise. The Division 22 Contractor shall provide all roof covering/membrane mounted equipment and pipe supports and roof drains, unless noted otherwise.
2. The Division 22 Contractor shall be liable for all associated costs to install the roof curbs, roof supports and roof penetrations not shown on the roof plan or added after the roof system has been installed. Coordinate with the General Contractor prior to construction the number size and location of all roof penetrations.
3. Division 22 Contractor is to coordinate with the General Contractor all roof curb and roof supports supplied, number, size and location of all roof penetrations. All major roof penetrations are shown on the architectural roof plan. General Contractor shall be notified of all additional roof penetrations provided by the Division 22 Contractor not shown on this plan.

F. Painting

1. The General Contractor is to field paint mechanical equipment and materials in specified areas as noted on the mechanical plans, mechanical schedules and in the specifications. Division 22 Contractor is to coordinate the painting of these items with the General Contractor. The Mechanical Contractor is to provide materials in these areas that are suitable for accepting paint. The clean and preparation of the materials to reach paint is the responsibility of the General Contractor unless noted specifically to be responsibility of the Division 22 Contractor.
2. In concealed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted with one coat of zinc rich paint.

3. In exposed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted in accordance with Section 09 91 00.

3.9 ELECTRICAL-PLUMBING EXTENT OF WORK

A. The responsibility of work specified under Division 22 and 26 is clarified under, Section 22 05 13, "Electrical Requirements for Plumbing Equipment. Division 22 Contractor is to coordinate all electrical requirements prior to ordering powered plumbing equipment.

END OF SECTION

PIPE PRESSURE TEST LOG

PROJECT:

BUILDING:

GENERAL CONTRACTOR:

CLARK ENERSEN PROJECT NUMBER:

MECHANICAL CONTRACTOR:

TEST INFORMATION						TEST PRESSURE					
TEST DATE	PIPING SYSTEM	AREA TESTED	TEST MEDIA (WATER OR AIR)	TEST DURATION (MINUTES)	PRESSURE GAGE NUMBER	INITIAL (PSIG)	FINAL (PSIG)	TESTED BY	WITNESSED BY	PASS / FAIL (P/F)	COMMENTS

ADDITIONAL COMMENTS:

PRESSURE GAGE INFORMATION

GAGE NUMBER	MANUFACTURER	PRESSURE RANGE	RESOLUTION	STYLE	DIAL SIZE	GAGE NUMBER	MANUFACTURER	PRESSURE RANGE	RESOLUTION	STYLE	DIAL SIZE

NOTE: USE MULTIPLE FORMS IF NECESSARY

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 05 13
ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

1. GENERAL

1.1 SECTION INCLUDES

A. Electrical Requirements for:

1. Motors
2. Starters, Electrical Devices, and Wiring
3. Manual Motor Starters
4. Motor Connections
5. Capacitors
6. Safety Switches

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Electrical components and materials shall be UL labeled and listed.

B. References.

1. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:

a. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
b. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
c. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
d. ANSI/NEMA Standard MG 1 – Motors and Generators.
e. ANSI/NFPA 70 - National Electrical Code.
f. NEMA Standard ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
g. NEMA Standard 250 – Enclosures for Electrical Equipment.
h. NEMA Standard KS 1 – Enclosed Switches.

C. Submittals.

1. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, or as required by the individual equipment specification sections.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and holding

G. Related sections.

1. Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.3 SUMMARY

A. This section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment. In addition, this section covers necessary coordination issues between plumbing and electrical disciplines. All plumbing and electrical construction documents must be completely reviewed by the Plumbing and Electrical Contractors prior to the submission of bids. Any discrepancies in the documents should be brought to the Architect/Engineer's attention at that time. Failure to properly coordinate or review documents in advance of submission of bids will not be valid cause for changes to the overall Contract amount.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

2. PRODUCTS

2.1 MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Minimum service factors shall be as follows:

Motor Service Factor Schedule		
Horsepower:	**3600 RPM:**	**1800 RPM:**
1/6 – 1/3	1.35	1.35
1/2	1.25	1.25
3/4	1.25	1.25
1 – 1.25	1.25	1.15
1.5 - 150	1.15	1.15

3. Two-speed poly-phase motors shall have two separate windings served by a single point electrical connection to the two speed starter. Two speed starters shall be located at the motor location unless otherwise noted.
4. Temperature Rating: Rated for 40 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
5. Starting capability: Frequency of starts as indicated by automatic control system, and not less than five (5) evenly timed starts per hour for manually controlled motors.
6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.

    a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit each specific application.
    b. Bearings: Ball or roller bearings with inner and outer shaft seals; re-greasable; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.
    c. Enclosure Type: Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation; guarded drip-proof motors where exposed to contact by employees or building occupants; weather protected Type I for outdoor use, Type II where not housed.
    d. Overload protection: Built-in thermal overload protection (in accordance with NEC requirements) and, where indicated, an internal sensing device suitable for signaling and stopping the motor at the starter.

7. Noise rating: "Quiet"
8. Efficiency: **"Premium efficiency"** motors, as defined in NEMA MG 1, most recent edition.
9. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
10. All three-phase motors shall be inverter duty type.
11. Motors Used With Variable Frequency Drives: Ratings, characteristics, and features coordinated with and approved by drive manufacturer. Motor shall be designed and labeled for use with variable frequency drives. Motor shall be designed with critical

vibration frequencies outside the operating range of the drive output and shall be suitable for use throughout speed range without overheating.

a. Provide AEGIS SGR, or approved equivalent, shaft grounding ring/system to divert adverse shaft currents away from the motor bearings. Use AEGIS Colloidal Silver Shaft Coating (PN CS015), or approved equivalent, prior to ring installation. Install coating and ring per manufacturer recommendations.

12. Motors Used for Wet or Corrosive Duty: Severe duty with cast-iron frame, epoxy finish, stainless steel nameplate, polymer shaft seal, corrosion-resistant fasteners and fan, moisture-resistant windings, and non-wicking leads.

PERFORMANCE SCHEDULE: THREE PHASE - ENERGY EFFICIENT, OPEN DRIP-PROOF

HP	RPM(Syn)	NEMA Frame	Minimum Percent Efficiency	Minimum Percent Power Factor
1	1800	143T	82	84
1.5	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	86	86
5	1800	184T	87	87
7.5	1800	213T	88	86
10	1800	215T	89	85
15	1800	256T	91	85
20	1800	256T	91	86
25	1800	284T	91	85
30	1800	286T	92	88
40	1800	324T	92	83
50	1800	326T	93	85
60	1800	364T	93	88
75	1800	365T	93	88
100	1800	404T	93	83
125	1800	405T	93	86
150	1800	444T	93	85
200	1800	445T	94	85
1.5	3600	143T	82	85
2	3600	145T	82	87
3	3600	145T	84	85
5	3600	182T	85	86
7.5	3600	184T	86	88

PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

HP	RPM(Syn)	NEMA Frame	Minimum Percent Efficiency	Minimum Percent Power Factor
1	1800	143T	82	84
1.5	1800	145T	84	85
2	1800	145T	8	85
3	1800	182T	87	83
5	1800	184T	88	83
7.5	1800	213T	89	85
10	1800	215T	90	84
15	1800	254T	91	86
20	1800	256T	91	85
25	1800	284T	92	84
30	1800	286T	93	86
40	1800	324T	93	83
50	1800	326T	93	85
60	1800	364T	93	87
75	1800	365T	93	87
100	1800	405T	94	86
125	1800	444T	94	87
150	1800	445T	94	88
200	1800	447T	95	87
1.5	3600	143T	82	85
2	3600	145T	82	87
3	3600	182T	82	87
5	3600	184T	85	88
7.5	3600	213T	86	86
10	3600	215T	86	86

2.2 SHEAVES

A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.

B. When replacing sheaves, use sheaves of at least the originally supplied sizes.

C. Contractor shall be responsible for replacement sheaves required to achieve specified performance. Coordinate with testing and balancing of the equipment.

2.3 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor-Starter Characteristics: Motor starters shall be compatible with the equipment they serve. In general, motor starter characteristics shall meet the requirements of Division 26 specification sections and as outlined as follows:

B. Motor Connections

1. Provide connections to motors in accordance with the requirements listed in the electrical specifications.
2. See Division 26 for the use of lugs for motor connections.

C. Capacitors

1. Capacitor features shall include:

a. Individual unit cells.
b. All welded steel housing.
c. Each capacitor shall be internally fused.
d. Non-flammable synthetic liquid impregnate.
e. Craft tissue insulation.
f. Aluminum foil electrodes

2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

D. FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

E. FULL VOLTAGE NON-REVERSING COMBINATION STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

F. MANUAL MOTOR STARTERS

G. See specification section 26 29 13 – Motor Controllers for requirements.

H. CAPACITORS

1. Capacitor features shall include:

a. Individual unit cells.
b. All welded steel housing.
c. Each capacitor shall be internally fused.
d. Non-flammable synthetic liquid impregnate.

e. Craft tissue insulation.
f. Aluminum foil electrodes

2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

2.4 SAFETY SWITCHES

A. See specification section 26 05 01 – Basic Electrical Materials and Methods.

3. EXECUTION

3.1

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

3.2 CONTRACTOR COORDINATION

A. It is the responsibility of the Contractor and all Subcontractors to coordinate scope to ensure that all required electrical connections and control connections are provided in accordance with all specification sections. The Architect/Engineer is not responsible for determining which Contractor or Subcontractor will provide particular items.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 05 19
PLUMBING METERS AND GAUGES

1. GENERAL

1.1 SECTION INCLUDES

A. Positive displacement meters.

B. Water meters.

C. Calibrated balance valves.

D. Pressure gages and pressure gage taps.

E. Thermometers and thermometer wells.

F. Piping pressure and temperature test plugs.

G. Sight flow indicators.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References

C. Submittals

D. Operation and maintenance manuals.

E. Project record documents

1. Accurately record actual locations of instrumentation.

F. Delivery, storage, and handling

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with International Plumbing Code.

B. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water meters, materials, piping, valves, fittings, backflow preventers, and other items in accordance with NSF/ANSI 61, including Appendix G.

C. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water faucets, faucet connectors, hoses, supply stops, and other items in accordance with NSF/ANSI 61, including Appendix 9-G.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

2. PRODUCTS

2.1 DOMESTIC WATER METER AND IRRIGATION DEDUCT WATER METER

A. Materials

1. The University of Missouri has standardized on bronze disc, and electromagnetic utility meters as manufactured by BadgerMeter, Milwaukee, WI. Substitutes will not be accepted.
2. Nutating Disc Meter

   a. Construction shall comply with ANSI and AWWA C700 standards as required for domestic water metering applications.
   b. Meter housing and housing top plate shall be lead free cast bronze construction. The measuring chamber, disc, strainer, and generator housing shall be thermoplastic construction. Register lid and box shall be thermoplastic and bronze and trim shall be stainless steel or bronze.
   c. Register shall be a straight-reading odometer-type totalization display (gallons), 360 degree test circle with center sweep hand and flow finder to detect leaks. Register shall be installed using TORX tamper resistant seal screws. Meters shall be provided with an integral strainer. A tamper resistant calibration plug seal shall also be provided to protect from unauthorized personnel.
   d. Meters shall be Recordall disc models 35, 70, 120 and 170.

3. Electromagnetic Meter

   a. Electromagnetic meter tube shall be constructed 316 Stainless Steel.
   b. Metering tube end connections shall be carbon steel flanged, according to ANSI B16, Class 150.
   c. Insulating liner material shall have a NSF lining.

d. Metering tube shall include two self-cleaning measuring electrodes. The electrodes shall be Alloy C.
e. Metering tube shall include a third “empty pipe detection” electrode located in the upper portion of the inside diameter of the flow tube.
f. Meter shall include a fourth, grounding electrode at the 5 o’clock position.
g. Meter shall include mounted amplifier.
h. Water meter shall be specified as DC powered, 10-36VDC.
i. Meter shall be Badger M2000 Electromagnetic Flow Meter with daughterboard for MODBUS RS485 communication, installed.

4. Water Pressure Sensor

a. A water pressure sensor shall be installed and wired to the EM Process Control Panel.
b. Keller Preciseline High Accuracy Pressure Sensor or approved equal. Pressure range of 0-200 psig. 4-20 + RS485 output, ½” NPT conduit fitting connector. - Part number 0308.01102.051903.13.

B. See Plumbing Meters Schedules for specific performance requirements.

2.2 CALIBRATED BALANCE VALVES

A. Pre-Set Balance Feature. Valves to be designed to allow Installing Contractor to pre-set balance points for proportional system balance prior to system start-up in accordance with scheduled flow rates.

B. Valve Design and Construction. All valves 1/2" to 3" pipe size to be of bronze body/brass ball construction with glass and carbon filled TFE seat rings. Valves to have differential pressure read-out ports across valve seat area. Read-out ports to be fitted with internal EPT insert and check valve. Valve bodies to have 1/4" NPT tapped rain/purge port. Valves to have memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position. All valves to have calibrated name plate to assure specific valve settings. Valves to be leak-tight at full rated working pressure.

C. Valves 4" pipe size to be of cast iron body/brass vane construction with differential pressure read-out ports fitted with internal EPT insert and check valve.

D. Performed Insulation. All vales to be provided with molded insulation to permit access for balance and read-out.

E. Design Pressure/Temperature.

1. 1/2" - 3" NPT connections 300 psig to 250 deg. F.
2. 1/2" and 3/4" Sweat connections 200 psig at 250 deg. F.

3. 4" flanged connections 125 psig at 250 deg. F.

F. Calibrated balance valves to be ITT Bell and Gossett Model CB or equivalent.

2.3 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection, liquid-filled.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. Vacuum: 30 inches Hg to 15 psi.
2. All fluids: 2 times operating pressure.

2.4 PRESSURE GAUGE ACCESSORIES

A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: ASME B40.100, 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure. Provide extension for use on insulated systems.

2.5 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

B. Scale range: Temperature ranges for services listed as follows:

1. Domestic Hot Water: 30 to 240 deg with 2-degree scale divisions (0 to 115 deg C with 1-degree scale divisions).
2. Domestic Cold Water: 0 to 100 deg F with 2-degree scale divisions (minus 18 to 38 deg C with 1-degree scale divisions).

2.6 LIQUID-IN-GLASS THERMOMETERS

A. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Red reading, mercury filled, magnifying lens.

D. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

F. ASME B40.200

2.7 GLASS THERMOMETERS

A. Standard: ASME B400.200.

B. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.

C. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Tube: Red reading, magnifying lens, with non-mercury fluid.

E. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.

F. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.8 THERMOMETER WELLS

A. Thermometer Wells: ASME B40.200, Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.9 PIPING PRESSURE AND TEMPERATURE TEST PLUGS

A. Test Plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:

1. Air, Water, Oil, and Gas, 20 to 200 deg F (minus 7 to 93 deg C): Neoprene.

2.10 SIGHT FLOW INDICATORS

A. Bronze or stainless-steel body, with sight glass and paddle wheel indicator, threaded or flanged ends.

B. Minimum pressure rating: 150 psig.

C. Minimum temperature rating: 200 deg F.

D. End connections for NPS 2 inch and smaller: Threaded.

E. End Connections for NPS 2-1/2 inch and larger: Flanged.

3. EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 THERMOMETERS

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Install as shown on drawings.

C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap. Provide extension on insulated systems. Install in socket extending to center of pipe.

D. Connect water meters to EMCS for remote reading capability.

3.3 PRESSURE GAUGES

A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most readable position.

B. Install as shown on plans, and elsewhere as indicated.

C. Pressure Gauge Ball Valves: Install in piping tee with snubber. Install syphon in lieu of snubber for steam pressure gages.

D. Pressure Gauge Accessories:

1. Install ball valve between system and pressure gauge.
2. Install in piping tee with snubber.

E. If applicable, cut rubber nipple on top of pressure gauge per manufacturer recommendations.

3.4 TEST PLUGS

A. Test Plugs: Install where indicated, located on pipe at most readable position. Secure cap.

3.5 FLOW MEASURING METERS

A. Installation:

1. Installation of water meter, valving, bypass loop and water sampler/test outlet shall be in strict accordance with manufacturer's printed instructions and recommendations, applicable ANSI and AWWA requirements, and as detailed on "Water_Meter Detail."
2. The preferred location for water revenue meter installation is within a building mechanical room. In some cases, water meter may need to be installed in an exterior below-grade meter pit. These pit installations shall be installed in strict accordance with manufacturer's printed instructions and University of Missouri "Meter Box Pit Detail" drawing.
3. Water meters shall be installed with a three-valve bypass design using ball valves (2" or less) or OS&Y rising stem gate valves (larger than 2"). The bypass valve shall be full-flow and capable of being locked. All other valves associated with the meter installation shall be ball valves. Electromagnetic water meters shall be installed in a straight run with no obstructions a minimum of ten diameters upstream and five diameters downstream. 2.4.
4. Water meter shall be installed after the backflow prevention device but prior to any booster pumps or pressure reducing valves.
5. Water meter shall be installed no greater than 4' from the floor in an accessible location. Variations from this requirement need prior approval from system owner.

B. Commissioning

1. Water service will not be turned on until the water meter is fully installed, powered and operating satisfactorily, the downstream water piping is successfully leak tested and secure (including freeze protection), and the necessary backflow preventer device is installed and successfully tested with the delivery of the test report to the Owner's Representative.
2. MU Only: Only Energy Management Steam and Water Distribution personnel will be authorized to turn water service on or off. Connect meter to EMCS. Coordinate with controls contractor and provide all necessary interconnections for accurate transmission of data.

3.6 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 22 05 29
PLUMBING HANGERS AND SUPPORTS

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe and equipment hangers, supports, stands, anchors, saddles and shields.

B. Sleeves and seals.

C. Mechanical sleeve seals.

D. Flashing and sealing equipment and pipe stacks.

E. Sealants, firestop insulation, putty and compounds.

F. Mechanical seals.

1.2 REFERENCES

A. ANSI/ASME B31.1 – Power Piping.

B. ANSI/AMSE B31.9 – Building Services Piping.

C. MSS SP-58 – Pipe Hangers and Supports – Materials, Design, and Manufacture.

D. MSS SP-69 – Pipe Hangers and Supports – Selection and Application.

E. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices.

1.3 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Submittals

C. Delivery, storage and handling

D. Quality Assurance

2. PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Plumbing Piping:

1. Conform to International Plumbing Code, International Fuel Gas Code, ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89 as applicable.

B. Deionized Water Piping and Laboratory Waste and Vent Piping:

1. Conform to manufacturer's recommendations, MSS SP58, MSS SP69, MSS SP89, as applicable. Refer to 22 67 00 and 22 10 00 for additional information.

C. Natural Gas Piping:

1. Conform to International Fuel Gas Code, MSS SP58, MSS SP69, MSS SP89, as applicable.

D. Compressed Air, Vacuum, and Laboratory Gas (Nitrogen, Argon, Helium, etc.) Piping:

1. Conform to ASME B31.9, MSS SP58, MSS SP69, MSS SP89, as applicable.

E. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

F. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

G. Hangers and Supports:

1. Hangers for Hot and Cold Pipe Sizes 1/2 to 1-1/2 Inch, Carbon steel, adjustable swivel, band type.
2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.

3. Hangers for Hot Pipe Sizes 2 to 4 Inches; Carbon steel, adjustable, clevis.
4. , cast iron roll, double hanger.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
7. Wall Support for Hot Pipe Sizes 6 Inches (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
10. Vertical Support: Steel riser clamp.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
14. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
15. Hangers for insulated pipe shall be enlarged to compensate for insulation thickness so that hangers support insulation. See Section 22 07 19.
16. Roof Support for Hot and Cold Pipe: See PIPE STANDS section below.
17. **Hangers for insulated pipe shall be enlarged to compensate for insulation thickness so that hangers support insulation. See Section 22 07 19.**
18. See Section 22 05 48 for vibration isolation hangers and supports.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Internally Threaded Screw Anchors: Internally threaded, self tapping screw anchors, Power Fasteners Snake or approved equivalent.

1. Tested in accordance with ACI 355.2 and ICC-ES AC193 for use in structural concrete under the design provisions of ACI318 (Strength Design method using Appendix D)

2.5 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength

2.8 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.9 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.10 FLASHING

A. Metal Flashing: 26 gage galvanized steel.

B. Metal Counterflashing: 22 gage galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb/sq ft sheet lead
2. Soundproofing: 1 lb/sq ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet buty; compatible with roofing.

E. Floor Drain and Floor Sink Flashing: 40 mil thick chlorinated polyethylene (CPE), equivalent to Chloraloy.

F. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.11 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage galvanized steel.

C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

D. Sleeves for Pipes Through Rated Floors and Walls: Schedule 40 steel pipe.

2.12 SEALANTS, FIRESTOP INSULATION, PUTTY, AND COMPOUNDS

A. Firestopping Insulation: Glass fiber type, non-combustible, UL listed.

B. Firestop Putty: Non-harding, non shrinking, UL listed.

C. Firestop Compounds: Cementitous material, non-shrinking, UL listed.

D. Sealants:

1. Non fire/smoke rated partitions: Acrylic or silicone based caulking.
2. Fire/smoke rated partitions: Silicone based caulking, UL listed.

2.13 MECHANICAL SEALS

A. Mechanical Seals: Modular mechanical type, consisting of interlocking EPDM synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with type 316 stainless steel bolts and reinforced plastic polymer pressure plates which cause rubber sealing elements to expand when tightened, providing a watertight and gas-tight seal and electrical insulation. Provide Advance Products & Systems Model Innerlynx or equivalent.+

1. A sleeve shall be provided for each mechanical seal.

a. Thermoplastic sleeves: Sleeve shall have smooth walls and shall be made of molded non-metallic high density polyethylene (HDPE) with an integral solid water stop, Advance Products & Systems Model PWS or equivalent.
b. Steel sleeves: Sleeve shall have smooth walls, shall be made of Schedule 40 steel with an integral welded solid water stop, and shall have corrosion-resistant coating, Advance Products & Systems Model GWS or equivalent.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 PIPE HANGERS AND SUPPORTS

A. Reference applicable codes for maximum support spacing; see Section 22 05 00. Additional supports shall be provided at other locations as specified in this Section.

B. Support piping adjacent to large pipe accessories such as valves, air separators, traps, etc. Provide additional supports as recommended by accessory manufacturer.

C. Independently support valves 16" and larger.

D. Install all hangers, supports, and accessories that shall be attached to structural steel prior to the application of structural steel fireproofing. Repair fireproofing if damaged during remainder of project.

E. Support horizontal piping as scheduled.

F. Support fire protection systems piping independently from other piping systems. Fire main piping may be trapezed with other piping systems. Coordinate trapeze hangers with the Sprinkler Contractor.

G. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

H. Place hangers within 12 inches of each horizontal elbow.

I. Use hangers with 1-1/2 inch minimum vertical adjustment.

J. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

K. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

L. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

M. Support riser piping independently of connected horizontal piping.

N. Provide copper plated hangers and supports for non-insulated copper pipe.

O. Design hangers for pipe movement without disengagement of supported pipe.

P. Prime coat steel hangers and supports in the mechanical room and other exposed areas. Refer to the Architectural reflected ceiling plans for location of exposed ceilings. Hangers and supports located in attic space, crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

Q. Adjust hangers to distribute loads equally on attachments and to achieve specified pipe slopes.

R. Space hangers for pure water and laboratory waste and vent systems to avoid pipe sags. Use manufacturer-recommended V-groove channel if necessary to maintain sag-free installation.

S. Saddles, Shields and Inserts

1. Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
2. Install protective shields MSS Type 40 on cold piping that has vapor barrier. Shields shall span an arc of 180 degrees (360 degrees on trapeze hangers with U-bolt clamps) and shall have dimensions in inches not less than the following:

NPS	LENGTH	THICKNESS
1 through 3-1/2	12	0.048
4	12	0.060
5 & 6	18	0.060
8 through 14	24	0.075
16 through 24	24	0.105

3. Pipes 8 inches and larger shall have wood inserts.
4. Insert materials shall be at least as long as the protective shield.
5. Provide manufacturer-recommended saddles, inserts, and/or shields where cellular foam insulation is used. The removal of sections of cellular foam insulation for the purpose of pipe support is not acceptable.

T. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

U. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

V. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

W. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

X. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

Y. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

Z. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

AA. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

BB. Install lateral bracing with pipe hangers and supports to prevent swaying.

CC. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

DD. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

EE. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

FF. Insulated Piping:

1. Attach clamps and spacers to piping.
    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   f. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
   g. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls and floors.

B. Flash floor drains in floors with topping over finished areas with CPE membrane, a minimum of 12 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

C. Seal floor, shower, mop sink, etc. drains watertight to adjacent materials.

D. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 SLEEVES

A. Provide pipe and duct sleeves at all fire/smoke rated partitions, exterior wall penetrations and wall penetrations into exposed areas. Pipe and duct sleeves are not required for penetrations through non-rated concealed partitions.

B. At the Contractor's option, pipe sleeves may be omitted if the wall or floor is core drilled, except in areas potentially exposed to wet conditions (such as mechanical rooms, loading dock, generator room, penthouse, kitchen, etc.).

C. Set sleeves in position in formwork. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Sleeves through floors shall be grinded flush with finish floor level. In areas potentially exposed to wet conditions (such as mechanical rooms, loading dock, generator room, penthouse, kitchen, etc.), sleeve shall extend a minimum of 2" above finish floor.

F. Where piping penetrates non-rated ceilings or walls, close off space between pipe or duct and adjacent work with urethane rod stock and caulk air tight.

G. Seal pipe penetrations through non-rated floors.

1. Where piping is not located in a rated shaft and it penetrates a single non-rated floor, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.
2. Where piping is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between pipe and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.

H. Where piping penetrates rated floor, ceiling, or wall, close off space between pipe or duct with appropriate fire rated sealant, insulation, putty or compound. Refer to the Drawings for fire/smoke rated wall locations and the appropriate ratings.

I. Install chrome plated steel escutcheons on piping at finished surfaces.

J. Waste, vent and storm pipe penetrations through the concrete floor slab shall be encased in the poured concrete slab.

K. PVC pipe casing around the cold and hot water and gas piping shall be encased in poured concrete when penetrating the floor slab. Seal the opening between the piping and PVC casing with putty or rigid polyisocyanurate insulation plug and seal with caulking.

L. Provide mechanical seals and sleeves through exterior wall and floor penetrations and 3 hour or higher fire rated partitions.

3.7 HANGER SCHEDULES

MAXIMUM PIPE SIZE Inches	**HANGER ROD HANGER SPACING** Feet	**DIAMETER** Inches
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
8 to 12	14	7/8
14 and Over	20	1
PVC (All Sizes)	6	3/8

A. Reference International Plumbing Code and International Fuel Gas Code where applicable.

B. Reference manufacturer's recommendations for pure water piping and laboratory waste and vent piping.

C. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

D. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

F. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

1. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Pipe Hangers

a. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
b. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
c. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
d. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
e. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
f. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
g. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
h. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
i. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
j. Vee Bottom Clevis Hanger: For suspension of flexible plastic piping, Cooper B-Line B3106 or equivalent. Include plastic pipe support channel, Cooper B-Line B3106V.

2. Pipe Clamps

a. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
b. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
c. Wall or Ceiling Mounted Pipe Strap/Clamp (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

3. Pipe Supports

a. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
b. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

c. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
d. Pipe Rollers (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
e. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
f. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. C-Clamps (MSS Type 23): For structural shapes. Shall only be connected to bottom joist chord if weight is 200 lbs or less.
6. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads. Shall only be connected to bottom joist chord if weight is 200 lbs or less.

7. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions. Shall only be connected to bottom joist chord if weight is 200 lbs or less.
8. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel. Shall only be connected to bottom joist chord if weight is 200 lbs or less.
9. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

10. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): For protection of pipe insulation; depth of saddle to be larger than insulation thickness. Fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections.

P. Comply with MFMA-103 for metal framing system selections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.8 MECHANICAL SEALS

A. Provide mechanical seals and sleeves through exterior wall and floor penetrations, and in 3-hour or higher fire rated partitions.

3.9 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.10 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.11 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

END OF SECTION

SECTION 22 05 33 - HEAT TRACE FOR PLUMBING PIPING

1. GENERAL

1.1 SECTION INCLUDES

A. Heat tracing for HVAC piping with the following electric heating cables:

1. Self-regulating, parallel resistance.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Manufacturer Qualifications:

a. ISO-09001 registered.
b. Provide products consistent with UL 515, CSA 22.2 No 130.16, and IEEE 515.1 requirements.

2. Installer Qualifications:

a. System Installer to have complete understanding of product and product literature from manufacturer or authorized representative prior to installation.
b. Electrical connections to be performed by licensed electrician.

3. Certification System (Heating Cable and Connection Kits): c-UL-us Listed for freeze protection of metallic and non-metallic piping associated with HVAC and Plumbing systems.
4. Testing: Self-regulating heating cable to be qualified and tested to demonstrate a useful lifetime in excess of 20 years.

B. References.

1. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:

a. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
b. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
c. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
d. ANSI/NEMA Standard MG 1 – Motors and Generators.

e. ANSI/NFPA 70 - National Electrical Code.
f. NEMA Standard ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
g. NEMA Standard 250 – Enclosures for Electrical Equipment.
h. NEMA Standard KS 1 – Enclosed Switches.

C. Submittals.

1. Product Data: For each type of product.

a. Include:

1) Heating cable data sheet.
2) HVAC piping freeze protection design guide.
3) System installation and operation manual.
4) System installation details.
5) Connection kits and accessories data sheet.
6) Controller data sheet.
7) Controller wiring diagram.

b. Include rated capacities, operating characteristics, and furnished specialties and accessories.
c. Schedule heating capacity, length of cable, and electrical power requirement for each electric heating cable required.
d. Include heat loss calculations for each pipe including pipe and insulation characteristics, heat loss, and watts per foot supplied by the heating cable.

2. Shop Drawings: For electric heating cable.

a. Include plans, elevations, sections, and attachment details.
b. Include diagrams for power, signal, and control wiring.
c. Manufacturer to produce detailed design as described below.

3. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Delegated design submittals include:

a. Heat Trace Circuit Layout Drawings, including:

1) Location/Identification of area to be traced.
2) Heater circuit number.
3) Electrical load.
4) Heater catalog numbers.

5) Heater termination points.
6) Start-up temperature.
7) Location of all components.
8) Material list and quantities of all components.
9) Heating cable layout.

b. Heat Trace Isometric, including:

1) Location of line.
2) Piping line numbers.
3) Valves, pumps, flanges, fittings, instruments.
4) Heat loss and heater output.
5) Electrical load.
6) Heater catalog number.
7) Heater termination points.
8) Design parameters.
9) Insulation type and thickness.
10) Position of all components.
11) Material schedule listing all components and quantities used.
12) Panel ID number.

c. Pipe Freeze Protection Detail Drawings: Project-specific Detail Drawings, including details showing:

1) Installation and positioning of all components.
2) Proper amounts of tracing for valves, pumps, flanges, fittings, instruments, etc.
3) Junction box layouts.

d. Control Panel Drawings: Drawings for each control panel shall include the following:

1) Physical arrangement and structural detail drawings.
2) Complete power and control wiring diagrams showing all internal wiring connections for electrical and instrument components in each control panel. All wires, terminals, and devices shall be numbered and tagged in accordance with system elementary diagrams.

e. System Wiring Diagram: Project-specific drawings (if applicable) including:

1) Interconnect of all major components.
2) Assignment of circuiting.
3) Connection of circuit wiring in terminal blocks.
4) Connection of sensor wiring.

5) Connection of external alarm wiring.

f. Controller Setpoint Schedule (if applicable) showing the following:

1) Circuit addresses.
2) Circuit set points,
3) Circuit alarms and settings.

4. Testing Instructions and Reporting Form: Provide documentation for use in preinstallation testing of heat-tracing system.

D. Operation and maintenance manuals.

1. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
2. Testing: Completed system test report.

E. Project record documents.

F. Delivery, storage, and holding

1. Deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:

a. Product and Manufacturer.
b. Length/Quantity.
c. Lot Number.
d. Installation and Operation Manual.
e. Material Safety Data Sheet (MSDS).

2. Store heating cable in clean, dry location with a temperature range of 0 to 140 deg F.
3. Protect heating cable ends from moisture ingress until final termination of the heating cable is complete.

G. Related sections.

1. Section 230719 - HVAC Piping Insulation
2. Division 26 specification sections.

H. Warranty

1. Manufacturer Limited Warranty: Manufacturer agrees to repair or replace heat tracing products listed below that fail in materials or workmanship within specified warranty period, when such goods are properly installed, operated, and maintained in accordance with product documentation.

a. Covered Products Include:

1) Heating cables, connection kits, and accessories.
2) Thermostats, controllers, panels, contactors, sensors, and accessories.

b. Warranty Period: Two years from date of Substantial Completion.

2. PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Complete pipe freeze protection system for insulated pipes exposed to the risk of freezing. System consists of a self-regulating heating cable, connection kits, accessories, and energy-efficient control and monitoring controller. The heating cable shall have a polyolefin jacket for aboveground water piping or a fluoropolymer jacket for below-grade piping.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage manufacturer to design complete and functional heat-tracing system as required by Project documents.

2.3 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Basis-of-Design Product: Subject to compliance with requirements, provide RAYCHEM, a brand of nVent; XL-Trace Edge Pipe Freeze/Flow Maintenance or equal.

B. Source Limitations: Obtain heat-tracing components and controllers from single manufacturer. To ensure system integrity and meet warranty requirements, only components and controllers supplied by cable manufacturer are to be used.

C. The heating cable and connection kit shall be included in a c-UL-us Listed system.

D. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end with a watertight end seal. Cable shall be capable of crossing over itself without overheating.

E. Electrical Insulating Jacket: Flame-retardant modified polyolefin.

F. Ground Braid: Tinned-copper braid. Minimum 70 percent for ground path and mechanical ruggedness.

G. Outer Jacket: Required for all applications.

1. For above ground freeze protection of water lines where fuel oil or aqueous chemicals are not present, use a modified polyolefin with ultraviolet inhibitor**.**
2. For below-grade applications, grease waste, or where fuel oil or aqueous chemicals are present, use a fluoropolymer with ultraviolet inhibitor**.**
3. Outer jacket to be printed with cable model number, agency listings, batch number, and meter marks (for ease of installation within maximum circuit length).

H. Maximum Operating Temperature (Power On): 154 deg F for 3 W/ft., 5 W/ft. , and 8 W/ft.

I. Maximum Exposure Temperature (Power Off): 185 deg F.

J. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

K. Capacities and Characteristics:

1. Nominal Heat Output at 50 deg F : See details on plans.
2. Piping Diameter: See details on plans.
3. Electrical Characteristics for Single-Circuit Connection:

2.4 CONTROLS

A. Single Circuit Local Digital Controller.

1. Basis-of Design Product: RAYCHEM; C910-485.
2. Control self-regulating heating cable via an energy saving, programmable single-circuit controller to provide adjustable maintained temperatures in the range of -40 to 140 deg F (-40 to 60 deg C).
3. Provide one controller for each heat-tracing circuit

4. Controller to include self-test function to verify heat-tracing integrity at least once every 24 hours.
5. Controller Capabilities:

    a. Supply Voltage: 100 to 277 V ac.
    b. Enclosure: NEMA 4X FRP.
    c. Operating Temperature Range: -40 to 140 deg F
    d. Display: Six-character, alphanumeric LED.
    e. Control: DP mechanical relay type.
    f. Control Algorithms: On/Off. Proportional Ambient Sensing Control for energy savings.
    g. Monitoring:

        1) Temperature:

            a) Low Alarm: 0 to 180 deg F
            b) High Alarm: 0 to 200 deg F

        2) Ground Fault:

            a) Alarm Range: 20 to 100 mA.
            b) Trip Range: 20 to 100 mA

        3) Current:

            a) Low Alarm Range: 3. to 20 A, or off.

        4) Autocycle Test: Interval of 1 to 240 minutes or 1 to 240 hours.

    h. Temperature Sensor Inputs:

        1) Quantity: Two.
        2) Type: 100 ohm, platinum, 3-wire, shielded.

    i. Alarm Outputs:

        1) AC Relay: Isolated solid state triac, SPST, 0.75 A maximum, 100 to 277 VAC nominal.
        2) Dry Contact Relay: Pilot duty, 48 V ac/dc, 500mA maximum, 10 V maximum resistive switching
        3) Outputs: Normally Open or Normally Closed.

j. Stored Parameters:

1) Minimum temperature.
2) Maximum temperature.
3) Maximum ground fault current.
4) Maximum heater current.
5) Contactor cycle count.
6) Time in use.

k. Alarm Conditions:

1) Low and High temperature.
2) Low current.
3) Ground fault alarm and trip.
4) RTD failure.
5) Loss of programmed values.
6) EMR failure.

l. Communications:

1) Protocol: Modbus RTU.
2) Topology: Daisy Chain.
3) 26 AWG shielded twisted pair.

6. Temperature Sensors:

a. For each temperature sensing controller, provide at least one of the following:

1) One 100-ohm, platinum, 3-wire, shielded RTD for pipe temperature sensing.

a) Basis-of-Design Product: RAYCHEM; RTD-10CS.

2) One 100-ohm, platinum, 3-wire, shielded RTD for ambient temperature sensing.

a) Basis-of-Design Product: RAYCHEM; RTD-200.

7. Approval: Complete heat trace system (heating cable, connection kits, and controller) shall be listed by a Nationally Recognized Testing (NRTL) and marked for intended use of freeze protection of HVAC piping.

B. Multi-Circuit Distributed Digital Control System:

1. Control and monitor pipe freeze protection using a centralized control system with distributed power and control modules.

    a. Basis-of Design Product: RAYCHEM; ACS-30.

2. Multi-application: Distributed digital control system shall be pre-programmed with parameters to provide concurrent control for heating cables used for pipe freeze protection, flow maintenance, HVAC piping, hot water temperature maintenance, surface snow melting, roof and gutter de-icing, freezer frost heave prevention, and floor heating applications.
3. Central User Interface Terminal: For all programming.

    a. Basis-of Design Product: RAYCHEM; ACS-UIT3.
    b. Certification: c-CSA-us Certified.
    c. Terminal Display: Color LCD display with password protection to prevent unauthorized system access.
    d. Capable of communicating with up to 52 power control panels, where each panel can control up to five circuits and accept up to five temperature inputs.
    e. Digital control system shall be capable of assigning up to four temperature inputs per heat-tracing circuit.
    f. Capable of communicating with up to 16 remote monitoring modules, where each module can accept up to eight temperature inputs.
    g. USB port to allow for quick and easy software update.
    h. Programmable Alarm Contacts: Three, including an alarm light on enclosure cover.
    i. Provide separate offline software tool to allow users to preprogram digital control system and transfer program via USB drive or Ethernet.
    j. Enclosure: NEMA 4 for indoor or outdoor locations.

4. Power Control Panels:

    a. Basis-of-Design Products: RAYCHEM; ACS-PCM2-5.
    b. Certification: c-UL-us Listed.
    c. Enclosure: NEMA 4/12 enclosure approved for nonhazardous indoor and outdoor locations.
    d. Provide ground-fault and line current sensing alarming, switching and temperature inputs for five heat-tracing circuits.
    e. Contactors: Five 3-pole, 30A contactors, EMR type.
    f. Capable of operating at 120 to 277 V.
    g. Alarm contact, including alarm light on panel cover.

5. Digital Controller:

    a. Integrated adjustable GFPD (10 to 200 mA).

b. Capable of being configured for On/Off, ambient sensing, PASC and timed duty cycle control modes based on the application. PASC control proportionally energizes power to heating cable to minimize energy based on ambient sensed conditions.
c. Upon communication loss with user interface terminal, panels shall control with the last downloaded set point.
d. Include built-in self-test feature to verify proper functionality of heating cable system.
e. BMS Communication Protocol: BACnet or Metasys N2.
f. Variables monitored by digital controller and reported back to BMS include:

1) Temperature.
2) Ground-fault.
3) Current draw.
4) Power consumption.
5) Associated alarms.

6. Approval: Complete heat trace system (heating cable, connection kits, and controller) shall be listed by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended freeze protection of metallic and non-metallic piping associated with HVAC, Plumbing, and Fire Suppression systems.

2.5 HEATING CABLE CONNECTION KITS

A. Basis-of-Design Product: RAYCHEM; RayClic.

B. Provide power connections, splices/tees, and end seal kits to properly connect and terminate heating cable circuit along specified length of piping.

C. Install splices, tees, and crosses underneath pipe insulation with service loops installed to allow for future service of piping.

D. Connection kits shall be rated NEMA 4X to prevent water ingress and corrosion. All components shall be UV stabilized and shall not require cutting into heating-cable core to expose bus wires.

E. Certification: c-UL-us Listed.

F. Locate connection kits above grade for buried applications.

2.6 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, cable ties, connection kits, and end seals all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Identification: Provide and install "Electric Heat Traced" labels on exterior of pipe insulation every 10 ft. (3 m) on opposite sides of pipe, and on all splices, tees, crosses, and power connections for entire length of heat traced piping.

C. Warning Labels: Refer to Section 230553 "Identification for HVAC Piping and Equipment."

D. Thermal Pipe Insulation:

1. Pipes to be thermally insulated in accordance with manufacturer's written requirements.
2. Thermal Insulation: Flame retardant, closed-cell with waterproof covering.

2.7 SYSTEM APPROVAL

A. Complete heat trace system (heating cable, connection kits, and controller) shall be listed by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended freeze protection of metallic and non-metallic piping associated with HVAC, Plumbing, and Fire Suppression systems.

3. EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Prior to installation of heating cable system, verify that all piping that will be heat traced has passed all hydrostatic/pressure tests and is signed off by plumbing inspector.
2. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Preinstallation Testing:

1. Prior to installation of heating cable on piping, an insulation resistance test shall be performed by installing contractor to ensure integrity of heating cable as describe in the installation and maintenance manual.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect all heating cable ends from moisture ingress until cable is terminated with end seals.

1. Basis-of-Design Product: RAYCHEM; RayClic-E end seals.

3.3 INSTALLATION

A. All heat-tracing components including power connections, splices, tees, and crosses or end seal, must be installed above grade and protected from abuse or damage. In accordance with NEC and CEC, electrical connections are not permitted to be installed below grade.

B. In the field, all heating cables shall be meggered with a minimum of 2,500 V dc for self-regulating cable. The following field megger readings shall be taken on each heating cable:

1. Heating cable shall be meggered when received at Project site before installation.
2. Heating cable shall be meggered after installation, but before insulation is installed.
3. Heating cable shall be meggered after insulation is installed.
4. Heating cable shall be meggered at final commissioning prior to being energized.
5. Insulation resistance must exceed 1.000 megohms at 2,500 V dc
6. All results must meet manufacturer's specification.

C. Install electric heating cables after piping has passed all hydrostatic pressure testing and before insulation is installed.

D. Install electric heating cables in accordance with IEEE 515.1.

E. Install insulation over piping with electric cables in accordance with Section 230719 "HVAC Piping Insulation."

F. Install warning tape on piping insulation where piping is equipped with electric heating cables.

G. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

A. Ground equipment in accordance with Division 26 sections.

B. Connect wiring in accordance with Division 26 sections

C. Pipe Insulation shall be in accordance with Section 230719 "HVAC Piping Insulation" and is required for a properly operating heat trace system.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Initial start-up and field testing (commissioning) of system shall be performed by factory technician in accordance with Owner's requirements.

B. Contractor to perform the following tests and inspections during installation:

1. Heating cable shall be meggered when received at Project site before installation.
2. Heating cable shall be meggered after installation, but before insulation is installed.
3. Heating cable shall be meggered after insulation is installed.

    a. Insulation resistance must exceed 1,000 megohms at 2,500 V dc.

4. All results must meet manufacturer's specification.
5. Test cables for electrical continuity during installation.
6. Test insulation integrity before energizing.
7. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

D. Cables will be considered defective if they do not pass tests and inspections in accordance with manufacturer's testing requirements.

E. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage and moisture ingress during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 05 48
PLUMBING VIBRATION CONTROLS

1. GENERAL

1.1 Coordinate requirements of this specification with all other specifications and trades. Requirements of this specification take precedence over other specification sections. For example, the requirements of this section with regard to pipe supports in mechanical rooms take precedence above the requirements of Section 22 05 29.

1.2 This specification pertains to the furnishing and installation of vibration isolation devices for rotating or reciprocating mechanical equipment and piping and conduit systems attached thereto, and electrical transformers and attached switchgear and conduit systems.

1.3 This work shall include all material and labor required for installation of the resilient mounting and suspension systems, adjusting each mounting system, and measurement of isolator system performance when so requested by the Architect. Specific mounting arrangements for each item of mechanical and electrical equipment shall be as described herein and as indicated by schedules and details on the drawings.

1.4 All vibration isolation equipment except for resilient pipe connectors, including steel framing and reinforcing for concrete inertia bases and including steel rail bases, shall be furnished by Mason Industries or Kinetics Noise Control. A single manufacturer for all vibration isolation equipment in Sections 22 05 48, 23 05 48, and 26 05 48 will be required except as specifically approved in writing by the Architect or by his specific approval of shop drawings or as specified herein. For resilient pipe connectors refer to provisions of this specification that follow.

1.5 SECTION INCLUDES

A. Vibration isolation systems.

1.6 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Submittals

C. Delivery, storage and handling

1.7 ADDITIONAL REQUIREMENTS

A. The Contractor and the vibration isolation manufacturer or his regularly designated and factory authorized representative shall perform the following tasks in addition to the supply and installation of isolation equipment:

1. Obtain from the Architect the approved manufacturer's name, model number, and other necessary identifying data for each item of mechanical and electrical equipment to be resiliently mounted. Coordinate all resilient mounting systems with the exact equipment to be furnished in regard to physical size, isolator locations, weight, rotating speed, etc. Direct contact and cooperation between the vibration isolation device fabricator and the equipment manufacturer will be required.
2. Obtain all necessary data in regard to piping systems which are to be resiliency supported so that proper isolators can be selected. Select piping system isolators for proper coordination with the physical arrangement of pipe lines and with the physical characteristics of the building.
3. Submit shop drawings as required by other portions of this specification. These drawings shall include specification information as follows:

    a. Manufacturer's model number for each isolator, the machine or pipeline to which it is to be applied, and the number of isolators to be furnished for each machine or pipeline.
    b. For steel spring mounts or hangers - Free height, deflected height, solid height, isolator loading, and diameter of spring coil.
    c. For elastomer or glass fiber isolators - Free height, deflected height, and isolator loading.
    d. Dimensional and weight data for concrete inertia bases, steel and rail bases, and details of isolator attachment.

4. Provide on-the-job supervision as required during installation of resiliently mounted equipment and piping to assure that all vibration isolators are installed in strict accordance with normally accepted practices for critical environments.
5. Replace at no extra cost to the Owner any isolators which do not produce the required deflection, are improperly loaded above or below their correct operating height, or which in any way do not produce the required isolation.
6. Cooperate with all other Contractors engaged in this project so that the installation of vibration isolation devices will proceed in a manner that is in the best interests of the Owner.
7. Notify the Architect of any project conditions which affect vibration isolation system installation or performance and which are found to be different from conditions indicated by the drawings or described by the specifications. Should vibration isolation system installation proceed without such notifications any remedial work required to achieve proper isolator performance shall be accomplished by the Contractor at no additional cost to the Owner.

8. Be alert for possible "short-circuiting" of vibration isolation systems by piping supports, electrical connections, temperature control connections, drain lines, building construction, etc., and notify the involved contractor as to these problems or potential problems. Where such situations cannot be easily resolved, notify the Architect so that preventive or remedial action can take place on a timely basis. Any remedial measures required shall be undertaken by the contractor responsible at no additional cost to the Owner.
9. This specification does not include provisions for seismic restraints that might be required by isolations systems due to the geographic location of the project, building codes, or other considerations.

2. PRODUCTS

2.1 VIBRATION ISOLATION SYSTEMS:

1. General:

   a. The vibration isolation systems described herein and identified by type letter designations shall be applied to specific classifications of mechanical and electrical equipment as indicated by Section C of this document.
   b. The minimum static deflection of the isolators for each classification of mechanical or electrical equipment shall be as indicated by Section C of this document or as otherwise indicated herein.

2. Type A Isolation:

   a. The equipment shall be rigidly mounted on a large reinforced concrete inertia base which has length and width dimensions approximately 20% greater than the supported equipment. The inertia base and equipment shall be supported by steel spring vibration isolators. Brackets for the spring isolators shall be located off the sides of the inertia base or integral with the perimeter of the inertia base with the tops of the springs near the vertical center of gravity of the equipment and inertia block; or if the center of gravity is higher than the top of the inertia base, the tops of the springs shall be at the top of the inertia base. The spring isolators shall rest on curbs or pedestals if necessary. There shall be a 2 inch minimum space between the bottom of the inertia base and the top of the housekeeping pad or floor slab when a housekeeping pad is not indicated to be employed.
   b. Concrete inertia bases shall be formed by a welded steel channel frame which incorporates prelocated equipment anchor bolts, and reinforcing bars in each direction welded in place. Concrete shall be standard 150-160 Ib/cu.ft. structural concrete. The base thickness shall be determined by the weight requirements but it shall be a minimum of 8% of the longest span between isolators or 6 inches, whichever is greater. For centrifugal and axial fans and centrifugal pumps the inertia base shall have a minimum weight equal to that of the isolated equipment. For reciprocating equipment the inertia base shall have a minimum weight equal to twice the weight of the equipment.

c. Springs shall be of the free standing unhoused type. Horizontal spring stiffness shall not be less than 0.8 of vertical stiffness. Springs shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection of each spring shall not be less than that specified for each classification of mechanical equipment. The spring deflection from the point of rated deflection to the point at which the spring is solid shall not be less than 1/2 of the rated static deflection. The yield point of the steel used in the springs shall be sufficiently great so that the springs may be compressed to shorted turns without danger of spring failure. At least two layers of ribbed waffle pattern neoprene pads or equivalent glass fiber pads shall be installed under the base plate of each spring isolator. Springs shall have leveling bolts and proper means for bolting to the machines. To prevent corrosion, springs for outdoor installation shall be galvanized or otherwise coated as approved by the Architect.

3. Type B Isolation:

a. The equipment shall be rigidly mounted on wide flange or channel structural steel members which shall run perpendicular to any support channels or similar members which are an integral portion of the equipment, or which shall be fabricated to form a complete frame for machine mounting. Height saving spring mounting brackets shall be welded to the ends of the structural steel saddle members or to the sides of structural steel frames to attach free standing steel spring isolators. Unless otherwise approved, the depth of the structural steel saddle members or the perimeter members of mounting frames shall be at least one-tenth of the longest frame dimension.
b. Steel spring isolators shall be as specified for Type A isolation.
c. Minimum clearance between the steel base and the housekeeping pad or floor shall be 2 inches.

4. Type C Isolation:

a. The equipment shall be rigidly mounted in a steel frame which is sufficiently stiff so that it may be supported on resilient isolators without distortion of the frame or misalignment of the equipment. If the equipment has an integral frame which is suitably rigid, the resilient isolators may be secured directly to the integral equipment frame or base.
b. Isolators shall be selected on the basis of the required static deflection as scheduled or otherwise indicated, and as follows:

1) Required deflection 0.25 to 0.4 inches - double deflection neoprene-in-shear isolators.
2) Required deflection 0.5 inches and greater - steel spring isolators as specified for the Type A mounting.

c. Isolators shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection shall not be less than that specified for each classification of equipment.
d. Minimum clearance between the equipment base and the house keeping pad or floor shall be 2 inches.

5. Type D Isolation:

a. The equipment shall be mounted on resilient "pads". These pads shall be multiple layers of waffle or ribbed neoprene, neoprene and cork sandwich, or precompressed glass fiber with height and stiffness as required to provide the static deflection as scheduled or specified and as required to properly support the load.
b. Pads shall be loaded in accordance with the manufacturer's recommendations and sized to achieve this recommended loading. The equipment weight at each sup porting point shall be considered in selecting pad dimensions along with the recommended loading.

6. Type E Isolation:

a. The equipment shall be suspended with steel spring vibration isolators which are complete with neoprene-in-shear isolators for high frequency noise control. The neoprene-in-shear isolators shall provide static deflection of 0.20 inches minimum. In addition, elastomer washers shall be furnished as necessary to prevent metal-to-metal contact.
b. Hanger rod misalignment of up to 15 degrees relative to vertical shall not cause "short-circuiting" of the isolation components due to metal-to-metal contact.
c. Spring hangers shall utilize free standing springs which are unhoused except for the required partial and open housing assembly. Spring hangers shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection of each hanger shall not be less than that specified for each classification of mechanical equipment. The spring deflection from the point of rated deflection to the point at which the spring is solid shall not be less than one-half of the rated static deflection. The yield point of the steel used in the springs shall be sufficiently great so that the springs may be compressed to shorted turns without danger of spring failure.
d. Resilient hangers shall be installed as near as possible to the supporting overhead structure. The machine suspension points shall be in a rigid and heavy portion of the building structure. Suspension of machines from lightweight floor slabs shall be avoided, particularly at the center of structural spans.
e. Suspension rods shall be attached to rigid members of the machine structure. When such attachment points do not exist, a heavy steel framework shall be furnished to support the machine with suspension rods attached to this framework.

7. Type F Isolation:

a. The equipment shall be suspended with double deflection neoprene-in-shear hangers which are complete with elastomer washers as required to prevent metal-to-metal contact.
b. Hangers shall be installed as near as possible to the supporting overhead structure. Suspension points shall be on a rigid portion of both the overhead structure and equipment framework.

8. Type G Isolation:

a. This mounting shall be the same as the Type E mounting except that the suspended machine shall be supported by a concrete inertia base. Suspension rods shall be attached to the concrete base.

9. Type K Isolation (Curb Mounted Roof-top Air Conditioning Machines):

a. The roof-top air conditioning machine shall be mounted on a free standing steel spring isolated rectangular rail (curb) system. The isolation system shall be suitable for outdoor unprotected locations and it shall include a soft and flexible elastomer air and water seal which shall not short circuit the spring isolators. The isolation system shall not allow lateral movement greater than 5/8 inch for wind loads up to 100 miles per hour. Suitable systems of this type are Kinetics Noise Control Type ESR and Mason Industries Type RSC.

10. Type L Isolation (Water Chillers and Similar Equipment):

a. Same as Type C except that steel spring isolators shall employ vertical limit stops with provisions to prevent short circuiting of the limit stops when the springs are loaded normally.

3. EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

C. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.5 ISOLATION OF PIPING SYSTEMS:

A. All piping and rigidly connected devices such as pressure reducing valves which connects to resiliently mounted equipment shall be suspended with resilient hangers or supported by floor mounted isolators for a distance of 100 pipe diameters from the connected machine or within the mechanical equipment room, whichever is the greater distance. The first three supports from the connected machine shall have the same static deflection as indicated for the machine; the next two supports shall have static deflection at least equal to one-half of the static deflection indicated for the machine mounting, and remaining pipe supports shall provide static deflection of 0.35 inches minimum. These remaining isolators may be elastomer.

B. Steel spring hangers shall be as specified for Type E isolation except that a scale shall be attached to the hanger housing to indicate deflection. Elastomer hangers shall be as specified for Type F isolation. Floor mounts shall be free standing steel spring isolators as specified for Type A isolation where static deflection in excess of 0.35 inches is required. Floor mounts, where static deflection of 0.35 inches or less is required, shall be double deflection neoprene-in-shear as specified for Type C isolation.

C. Vertical pipe risers shall be resiliently mounted, preferably with each riser anchored near the center of the run. The risers shall be supported at the anchor points with steel spring or double deflection neoprene-in-shear isolators which provide static deflection of at least 0.35 inches. Isolators for the remainder of each run shall be steel spring type specifically designed to control load shifting due to pipe expansion and contraction. At least 0.35 inches deflection shall be maintained under all conditions.

D. Flexible synthetic rubber connectors shall be used to connect all piping to all isolated equipment. Flexible synthetic rubber connectors shall be fabricated using peroxide cured EPDM synthetic rubber and Kelvar tire cord reinforcement and shall be Mason Industries Safeflex of the most current design. Resilient connectors shall be selected for the pressure rating and temperature rating appropriate for the particular piping and pipe contents. Where synthetic EPDM flexible connectors are not permitted by code due to pipe contents and/or pressures provide swing pipe connectors changing direction a minimum of 3 times before joining isolated equipment. Swing connections should be made within approximately 6 feet of the isolated equipment.

E. Drain connections from isolated equipment to floor drains shall be at least 1" free from drain or use rubber hose.

3.6 ISOLATION OF FRACTIONAL HORSEPOWER EQUIPMENT:

A. All fractional horsepower fans, pumps, etc., which are mounted on or suspended from floors that are not on-grade shall be isolated with neoprene-in-shear isolators furnished by the vibration isolation supplier except where such isolators are furnished as an integral part of the machine.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 05 53
PLUMBING IDENTIFICATION

1. GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe Markers.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Related Sections

C. Submittals

D. Quality Assurance

1.3 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01700

B. Record actual locations of tagged valves.

2. PRODUCTS

2.1 NAMEPLATES

A. Equipment Mark Nameplates: Laminated three-layer plastic with engraved black letters (matching equipment mark indicated on drawings) on light contrasting background color, with minimum 3/4 inch high letters.

B. Equipment Nameplates: Factory-applied permanent nameplate indicating the manufacturer's name, model, serial number, temperature and pressure design, and any other data necessary to conform with specified requirements. On equipment installed outdoors, nameplate shall be stamped steel or engrave plastic.

2.2 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.

B. Chart: Typewritten list that is plastic laminated and mounted in mechanical room. Valve list is to coordinate with mechanical piping schematics if provided on plans.

C. Pipe Schematics: Valve numbers are to be labeled on Engineer schematic drawings, plastic laminated and schematic shall be mounted in mechanical room.

2.3 PIPE MARKERS

A. Color: Conform to ASME A13.1.

B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service. Provide tape with printing which most accurately indicates the type of service of buried pipe.

D. The following abbreviations shall be used on actual labels:

1. CW – Domestic cold water
2. HW – Domestic hot water
3. HWR – Domestic hot water return
4. SW – Sanitary waste
5. SV – Sanitary vent
6. SPD – Sump pump discharge
7. ST – Storm water

3. EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe and duct markers in accordance with manufacturer's instructions. Directional arrow tape shall be overlapped to ensure proper adhesion and no peeling of tape in future.

D. Identify air handling units, exhaust fans, chillers, pumps, heat generating, heat rejecting, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

E. Identify pressure reducing valves, backflow preventers, valves, and meters with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Tag automatic controls, instruments, and relays. Key to control schematic.

I. Identify piping, concealed or exposed, with plastic tape pipe markers. For pipes ¾" and smaller, identify piping with tags. Identify service, flow direction, and pressure when applicable, i.e. low pressure steam, high pressure steam. Install in clear view from floor and align with axis of piping. Locate identification not to exceed 15 feet on straight runs including risers and drops, more often in congested areas, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Provide a minimum one label per pipe per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.

J. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

1. Provide 14 gauge electrical tracer wire above all underground pipe (plastic or other type of utility piping).

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 07 16
PLUMBING EQUIPMENT INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Equipment insulation.

B. Covering.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. REFERENCES.

B. SUBMITTALS

C. QUALITY ASSURANCE

1. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723.

D. DELIVERY, STORAGE AND HANDLING

E. ENVIRONMENTAL REQUIREMENTS

1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
2. Maintain temperature during and after installation for minimum period of 24 hours.

2. PRODUCTS

2.1 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. 'K' ('ksi') value: ASTM C177 or C518; 0.27 at 75 degrees F.
2. Minimum service temperature: -40 degrees F.
3. Maximum service temperature: 220 degrees F.
4. Maximum moisture absorption: ASTM D1056; 1.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.
5. Moisture vapor transmission: ASTM E96; 0.20 perm inches.

6. Maximum flame spread: ASTM E84; 25.
7. Maximum smoke developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.

B. Elastomeric Foam Adhesive: MIL-A-24179A, Type II, Class I, compliant. Air dried, contact adhesive, compatible with insulation. VOC Limit: 50 g/L or less when calculated according to 40 CFR 59, Subpart D.

2.2 JACKETS

A. PVC Plastic

1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, white color.

a. Minimum Service Temperature: -40 degrees F.
b. Maximum Service Temperature: 150 degrees F.
c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
d. Maximum Flame Spread: ASTM E84; 25.
e. Maximum Smoke Developed: ASTM E84; 50.
f. Thickness: 20 mil.
g. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.

2. Covering Adhesive Mastic: Compatible with insulation. VOC Limit 50 g/L according to 40 CFR 59, Subpart D (EPA Method 24).

3. EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on equipment subsequent to testing and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Do not use cut pieces or scraps abutting each other.

D. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

E. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

F. Replace damaged insulation which cannot be repaired satisfactorily.

G. Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

H. Painting of cellular foam insulation is not allowed.

I. For equipment in mechanical equipment rooms or in finished spaces, finish with PVC jacket sized for finish covering.

J. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.

K. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

3.3 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 CELLULAR FOAM INSULATION SCHEDULE

Equipment:	Thickness (inches):
Hot water equipment furnished without factory insulation	1-1/2”
Cold systems pump bodies	1-1/2"
Cold flanged strainer bodies.	1-1/2"
Cold system tanks/vessels	1-1/2”
Condensate drain pans	1-1/2”

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 07 19
PLUMBING PIPING INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

A. Quality assurance.

1. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, and UL 723.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

F. Environmental requirements

1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
2. Maintain temperature during and after installation for minimum period of 24 hours.

2. PRODUCTS

2.1 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. 'k' ((btu*in)/(hr*ft^2*deg F)) value: ASTM C177 or C518; 0.21 to 0.27 at 75 degrees F mean temperature rating.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 220 degrees F.
4. Maximum Moisture Absorption: ASTM C209; 0.2 percent by volume.

5. Moisture Vapor Transmission: ASTM E96; 0.08 perm inches.
6. Maximum Flame Spread: ASTM E84; 25.
7. Maximum Smoke Developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.
9. Provide documentation indicating that product contains no urea formaldehyde.
10. Fittings: Pre-fabricated closed cell fittings of like material and thickness as adjacent pipe insulation.
11. In all exposed finished areas without jacketing, provide white insulation, otherwise use black.

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. MIL-A-24179A, Type II, Class I, compliant. Air dried, contact adhesive, compatible with insulation. VOC Limit: 50 g/L or less when calculated according to 40 CFR 59, Subpart D.

2.2 JACKETS

A. PVC Plastic

1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, white color.

   a. Minimum Service Temperature: -40 degrees F.
   b. Maximum Service Temperature: 150 degrees F.
   c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
   d. Maximum Flame Spread: ASTM E84; 25.
   e. Maximum Smoke Developed: ASTM E84; 50.
   f. Thickness: 20 mil.
   g. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.

2. Covering Adhesive Mastic: Compatible with insulation. VOC Limit 50 g/L according to 40 CFR 59, Subpart D (EPA Method 24).

3. EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. On exposed piping, locate insulation and cover seams in least visible locations. For cellular foam insulation tape ALL visible seams with tape matching insulation color.

E. All new interior piping that is exposed in mechanical rooms, and is within 6'-0" of the finished floor, shall have a PVC jacket installed.

F. Any exposed piping within 6’-0” of the finished floor in an occupied space shall have a PVC jacket installed.

G. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

H. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

I. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

J. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

K. Where piping passes through fire walls indicated on the contract drawings, contractor shall install firestopping per firestop manufacturers instructions.

L. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

M. Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

N. Repair damaged sections of existing mechanical insulation, damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

O. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

P. Wood blocking shall not be used

Q. **Painting of cellular foam insulation is not allowed.**

R. Insulated pipes conveying fluids below ambient temperature:

1. Insulate fittings, joints, flanges, unions strainers, flexible connectors and valves with molded insulation of like material and thickness as adjacent pipe.
2. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
3. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

S. For insulated pipes conveying fluids above ambient temperature:

1. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
2. For hot piping conveying fluids, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

T. Inserts and Shields:

1. Refer to Section 22 05 29 for additional information.
2. Application: Piping 1 inch diameter or larger.
3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
4. Insert Location: Between support shield and piping and under the finish jacket.
5. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
6. Provide inserts and/or shields per manufacturer recommendations for cellular foam insulation applications in order to maintain continuous insulation throughout the pipe system. The removal of sections of cellular foam insulation to accommodate pipe supports is not acceptable. Manufacturer products specifically designed for supporting insulation and maintaining the integrity of the insulation system at pipe hanger locations, such Armaflex Armafix Insulation Pipe Hangers, are acceptable.

U. All valves in insulated systems shall have valve stem extensions. Insulation installer shall notify the contractor and Owner if valves without stem extensions are encountered. All valves without stem extensions in areas where stem extensions are required shall be replaced.

V. **Provide insulation clearance and access to valves and fittings in hangers and from structure and other equipment. Insulation shall be continuous through all hangers and supports. Refer to Section 23 07 19.**

3.3 TOLERANCE

A. Substituted insulation materials, where allowed, shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 CELLULAR FOAM INSULATION SCHEDULE

A. Plumbing Systems

PIPING SYSTEM:	PIPE SIZE:	MIN. THICKNESS:
Domestic Hot Water Supply	1-1/4" & smaller	1"
Domestic Hot Water Supply	1-1/2" & larger	2”
Domestic Hot Water Recirc	1-1/4" & smaller	1"
Domestic Cold Water Supply	All sizes	1"
Soft Cold Water Supply	All sizes	1"
Tempered Domestic Water	All sizes	1”
Tempered Water Recirc	All sizes	1"
Pure Water (Exposed)	6" & smaller	1"
Pure Water (Concealed)	6” & smaller	None
Cold Condensate Drain Piping	6” & smaller	1”
Refrigerant Piping	1-1/2" & smaller	1”
Refrigerant Piping	2" & larger	2”
Roof Drain Bodies	All sizes	1"
Roof Drainage Above Grade	All sizes	1"
Plumbing Vents Within 20 Feet of the Exterior	All sizes	1"
Sanitary Waste Piping Serving Floor Drains/Sinks up to 15’ downstream	All sizes	1”

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 10 00
PLUMBING PIPING

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe and pipe fittings.

B. Valves.

C. Sanitary waste and vent piping system.

D. Sump pump discharge piping system.

E. Water piping systems.

F. Storm water piping system.

G. Natural gas piping system.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Valves: Manufacturer's name and pressure rating marked on valve body.

B. References

C. Submittals

D. Operation and maintenance manuals.

E. Project record documents

1. Record actual locations of valves.

F. Delivery, storage, and handling

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with International Plumbing Code.

B. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water meters, materials, piping, valves, fittings, backflow preventers, and other items in accordance with NSF/ANSI 61, including Appendix G.

C. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water faucets, faucet connectors, hoses, supply stops, and other items in accordance with NSF/ANSI 61, including Appendix 9-G.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.5 EXTRA MATERIALS

A. Provide two repacking kits for each size valve.

2. PRODUCTS

2.1 SANITARY WASTE AND VENT PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665, solid-wall. Cellular core piping is not allowed. (Used only for fluid streams less than 120 Deg. F)

1. Fittings: PVC, ASTM D2665, made to ASTM D3311, DWV patterns and to fit Schedule 40 pipe.
2. Joints: Solvent cement, ASTM D2564; and adhesive purple primer, ASTM F656.

2.2 SANITARY WASTE AND VENT PIPING, ABOVE GRADE

A. PVC Pipe: ASTM D2665, solid-wall. Cellular core piping is not allowed. (Used only for fluid streams less than 120 Deg. F)

1. Fittings: PVC, ASTM D2665, made to ASTM D3311, DWV patterns and to fit Schedule 40 pipe.
2. Joints: Solvent cement, ASTM D2564; and adhesive purple primer, ASTM F656.

2.3 STORM AND OVERFLOW STORM PIPING, ABOVE GRADE

A. PVC Pipe: ASTM D2665, solid-wall. Cellular core piping is not allowed. (Used only for fluid streams less than 120 Deg. F)

1. Fittings: PVC, ASTM D2665, made to ASTM D3311, DWV patterns and to fit Schedule 40 pipe.
2. Joints: Solvent cement, ASTM D2564; and adhesive purple primer, ASTM F656.

2.4 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665, solid-wall. Cellular core piping is not allowed. (Used only for fluid streams less than 120 Deg. F)

1. Fittings: PVC, ASTM D2665, made to ASTM D3311, DWV patterns and to fit Schedule 40 pipe.
2. Joints: Solvent cement, ASTM D2564; and adhesive purple primer, ASTM F656.

B. Piping shall be a minimum 4" diameter. See drawings for sizes.

2.5 WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Tubing: ASTM B88, Type K, hard drawn.

1. Fittings: ASME B16.18, cast bronze or ASTM B16.22 wrought copper and bronze.
2. Joints: AWS A5.8, BCuP silver braze.

B. PVC Pipe: AWWA C900; Pressure Class 235 (DR 18); Cast Iron O.D. equivalent; with bell end and elastomeric gasket.

1. Gaskets: ASTM F477, elastomeric seal.

2.6 WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper and bronze.
2. Joints: Lead Free, ASTM B32, Alloy B solder, for piping 1-1/2" and smaller. AWS A5.8, BCuP silver braze, for piping 2" and larger.
3. At contractor's option, mechanical pressed copper fittings may be used. Joints shall be double pressed type complying with ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements shall be EPDM and factory installed. Fittings shall be Viega, Mueller or approved equal.

2.7 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53 or A120, Schedule 40 black.

1. Fittings: ASME B16.3, malleable iron, or ASTM A234, forged steel welding type.
2. Joints: NFPA 54, threaded or welded to ANSI B31.1, ANSI B31.2, ANSI B31.9, ASME Sec 1.

2.8 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2 Inches and Under:

1. Ferrous pipe: 150 psig malleable iron threaded unions.
2. Copper tube and pipe: 150 psig bronze unions with soldered joints.

B. Pipe Size Over 2 Inches:

1. Ferrous pipe: 150 psig forged steel slip-on flanges; 1/16 inch thick preformed neoprene gaskets.

2.9 Copper tube and pipe: 150 psig slip-on bronze flanges; 1/16 inch thick preformed neoprene gaskets.

2.10 DIELECTRIC NIPPLE

A. Standard: IAPMO PS 66.

B. Electroplated steel nipple complying with ASTM F1545.

C. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F.

D. End Connections: Male threaded.

E. Lining: Inert and noncorrosive, propylene.

2.11 SWING CHECK VALVES

A. Up to and including 2 Inches: Bronze swing disc, 125 psig working pressure.

B. Over 2 Inches: Cast iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.

2.12 BALL VALVES

A. Up to and including 4 inches: Bronze two piece body, lead, free, chrome plated steel full-port ball, teflon seats and stuffing box ring, lever handle.

2.13 BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:

1. Standard: MSS SP-67, Type I.
2. CWP Rating: 200 psig
3. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
5. Seat: EPDM
6. Stem: One- or two-piece stainless steel.
7. Disc: Aluminum bronze.

2.14 STRAINERS

A. Size 2 inch and Under: Screwed bronze body for 250 psig working pressure, Y pattern with 20-mesh stainless steel perforated screen.

B. Size 2-1/2 inch and larger: Flanged cast iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.15 GAS VALVES

A. Gas Cocks 2 Inch and Smaller: 150 psi WOG, bronze body, straightaway pattern, square head, threaded ends.

B. Gas Cocks 2-1/2 Inch and Larger: MSS SP-78; 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.

C. Solenoid Valves: Aluminum body, 120 volts AC, 60 Hz, Class B continuous duty molded coils; NEMA 4 coil enclosure; electrically opened/electrically closed; dual coils; normally closed; UL and FM approved and labeled.

D. Gas Line Pressure Regulators: Single stage, steel or aluminum jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; with threaded ends for 2 inch and smaller, flanged ends for 2-1/2 inch and larger; for inlet and outlet gas pressures, specific gravity, and volume flow indicated.

2.16 CALIBRATED BALANCE VALVES

A. Pre-Set Balance Feature. Valves to be designed to allow Installing Contractor to pre-set balance points for proportional system balance prior to system start-up in accordance with scheduled flow rates.

B. Valve Design and Construction. All valves shall have a calibrated orifice or venturi section, two ¼" threaded pressure tap ports with integral seals, and memory stop to retain the set position. Valves should be rated for 125 psig working pressure and 250 Deg. F maximum operating temperature.

C. Valves shall be selected based on flowrate, not on pipe size dimensions.

D. Preformed Insulation. All vales to be provided with molded insulation to permit access for balance and read-out.

2.17 DRAIN VALVES

A. Equipped with hose adaptor fitting and cap.

3. EXECUTION

3.1 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Vent pipes shall extend minimum 12” above finish roof line or as required by code.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access where valves and fittings are not exposed.

J. Establish elevations of buried sanitary and storm piping outside the building to ensure not less than 3 ft of cover.

K. Establish elevations of buried water piping outside the building to ensure not less than 5 ft of cover.

L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

M. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.

N. Install bell and spigot pipe with bell end upstream.

O. Install valves with stems upright or horizontal, not inverted.

P. Extend chains on valves with chainwheel operators down to maximum 5-feet above finished floor.

Q. Install strainers in horizontal pipe or in vertical pipe such that flow is downward. Do not install strainers in vertical pipe with flow upward.

R. Install cast iron piping system according to CISPI Handbook.

S. Install copper tubing under building slab according to CDA's "Copper Tube Handbook." Install ball valve directly upstream of each floor slab penetration.

T. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105.

U. Install ball valve at all laboratory water connections to fume hoods and other laboratory equipment.

V. Install natural gas shutoff valves at each required piece of equipment. Provide gas regulators as necessary to accommodate equipment pressure requirements. Coordinate with equipment vendor.

3.4 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install valves for shut-off and to isolate equipment, part of systems, and vertical risers.

C. Install ball valves for throttling, bypass, or manual flow control services.

D. Provide spring loaded check valves on discharge of water pumps.

E. Provide plug valves in natural gas systems for shut-off service.

F. Provide flow control valves in water recirculating systems where indicated. Balance flow to maintain hot water at all plumbing fixtures.

G. Main Water Service Entry Piping:

1. Install buried water piping in accordance with requirements specified in section 33 11 00.

H. Natural Gas Piping:

1. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
2. Outdoor Piping:

a. Paint piping, fittings, and equipment that are exposed to view from grade with factory-applied paint or protective coating. This includes but is not limited to: exterior metal piping, valves, service regulators, service meters and meter bars, and piping specialties.

1) Alkyd System: MPI EXT 5.1D.

a) Prime Coat: Alkyd anticorrosive metal primer.
b) Intermediate Coat: Exterior alkyd enamel matching topcoat.
c) Topcoat: Exterior alkyd enamel semigloss
d) Color: By Architect

3.5 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum or as indicated on drawings. Maintain gradients.

B. Slope water piping and arrange to drain at low points.

3.6 PLUMBING PIPING PRESSURE TESTING

A. Test for leaks and defects all new plumbing piping systems and parts of existing systems, which have been altered, extended or repaired. Submit copy of Pipe Pressure Test Log provided in section 22 05 00 for each section of piping tested. Refer to International Plumbing Code for general pipe pressure testing requirements (i.e., test pressure gauges, inspections, etc.).

B. Leave uncovered and unconcealed all new, altered, extended, or replaced piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

C. Repair all leaks and defects using new materials and retest all plumbing systems until satisfactory results are obtained.

D. Natural Gas Piping System.

a. Test in accordance with International Fuel Gas Code, NFPA 54, and local utility requirements.

3.7 DISINFECTION OF WATER PIPING SYSTEMS

1. After water systems have been pressure tested and flushed, each system (including distribution system to building) shall be cleaned and disinfected per AWWA C651. Note that procedures shall require two (2) consecutive sets of acceptable samples taken at least 24 hours apart.
2. Take samples no sooner than 24 hours after flushing, from outlets and from water entry per AWWA 651, and analyze in accordance with AWWA C651.
3. Samples shall be subject to bacteriological testing by a recognized 3rd party testing agency. Send test reports to Owner for review. If unsatisfactory bacteriological results are found, the system shall be disinfected and retested again until satisfactory results are obtained.

3.8 SERVICE CONNECTIONS

A. Provide new sanitary and storm sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved backflow preventer and water meter with by-pass valves.

1. Provide sleeve in wall for service main and seal at wall/floor with mechanical sleeve seals. Anchor service main inside to concrete wall/floor.

END OF SECTION

SECTION 22 11 19
PLUMBING SPECIALTIES

1. GENERAL

1.1 SECTION INCLUDES

A. Backflow preventers.

B. Expansion tanks.

C. Cleanouts.

D. Water hammer arresters.

E. Floor drains and floor sinks.

F. Hose bibs.

G. Installation requirements of other plumbing specialties scheduled in Plumbing Specialties Schedule.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References

C. Submittals

D. Operation and maintenance manuals.

E. Project record documents

F. Delivery, storage, and handling

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with International Plumbing Code.

B. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water meters, materials, piping, valves, fittings, backflow preventers, and other items in accordance with NSF/ANSI 61, including Appendix G.

C. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water faucets, faucet connectors, hoses, supply stops, and other items in accordance with NSF/ANSI 61, including Appendix 9-G.

1.4 BACKFLOW PREVENTERS

A. Refer to Plumbing Specialties Schedule on drawings for required product information.

B. Reduced-Pressure-Principle Backflow Preventers

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Body: Bronze for 3" and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for 4" and larger.
4. End Connections: Threaded for NPS 3 and smaller; flanged for NPS 4" and larger.
5. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 3" and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 4" and larger.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

6. Manufacturers: Watts or Zurn/Wilkins.

C. Double-Check Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications, unless otherwise indicated.
3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
5. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

6. Manufacturers: Watts or Zurn/Wilkins.

1.5 DIAPHRAGM TYPE EXPANSION TANKS

A. Refer to Plumbing Specialties Schedule on drawings for required product information.

B. Construction:

1. Shell: High Strength Steel
2. Diaphragm: Heavy Duty Butyl NSF/ANSI 61
3. Liner: Antimicrobial
4. System Connection: Stainless Steel
5. Water Circulator: Patented Turbulator
6. Air Valve: Projection Welded
7. Air Valve Cap
8. Factory Precharge: 50 psig.

C. Performance:

1. Max. Operating Temperature: 200 deg F
2. Max. Working Pressure: 150 psig

D. Manufacturer/Model: Amtrol Therma-X-Trol Series or equivalent.

1.6 CLEANOUTS

A. Exterior Surfaced Areas: Round or Square cast nickel bronze access frame and non-skid cover.

B. Interior Finished Floor Areas: cast iron body and frame, nickel bronze top to accommodate the following floor finishes as required:

1. Exposed rim type with recess to receive tarrazzo or resilient floor finish.
2. Exposed finish type with standard mill finish.
3. Exposed flush type with standard scored or abrasive finish.
4. Concealed undercarpet flush type with mill finish and carpet marker.

C. Interior Finished Wall Areas: Line type with cast iron body and round gasket cover and round stainless steel access cover secured with machine screw.

D. Interior Unfinished Accessible Areas: Caulked or threaded type.

1.7 WATER HAMMER ARRESTERS

A. Standard: ASSE 1010 or PDI-WH 201.

B. Type: Metal bellows or copper tube with piston.

C. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F. Size per manufacturer recommendations.

1.8 WATER HAMMER ARRESTERS

A. Standard: ASSE 1010 or PDI-WH 201.

B. Type: Diaphragm.

C. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

1.9 OTHER SPECIALTIES

A. Refer to Plumbing Specialties Schedule for required product information.

2. EXECUTION

2.1 PREPARATION

A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

2.2 INSTALLATION

A. All Plumbing Specialties:

1. Install in accordance with manufacturer's instructions.

B. Cleanouts:

1. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
2. Encase exterior cleanouts in concrete flush with grade.

C. Backflow Preventers:

1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to either building exterior or floor drain (coordinate with plans). Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

2. If equipped with a relief valve, pipe relief from backflow preventers to nearest drain. Piping diameter of drain piping shall match outlet diameter of air gap fitting.
3. Provide final certification for all testable backflow preventers, after installation, by certified cross connection device tester. Submit copy of successful test to Owner's Representative.

D. Water Hammer Arrestors:

1. Install water hammer arrestors complete with accessible isolation valve according to PDI-WH 201 and as shown on drawings.

E. Floor Drains / Floor Sinks:

1. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
2. Position floor drains for easy access and maintenance.
3. Unless dimensioned on drawings, location of drains shown on plans are approximate. Installing contractor shall be responsible for coordinating final location with other trades to ensure proper coordination with other building elements including but not limited to: structural members (above/below grade), owner-furnished equipment, walls, and bathroom partitions. Upon identifying a coordination conflict, the contractor shall notify the Engineer of Record by way of RFI with suggested location for drain and obtain approval of new location. No additional compensation shall be provided by Owner for lack of coordination.
4. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

5. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
6. Install barrier-type trap seal protection device in all floor drains and sinks, unless noted otherwise on plans.
7. Provide deep seal traps in all locations when possible.

2.3 TESTING

A. Test and certify all backflow preventers for proper operation. Testing agent shall be Grade VI Water Operator.

1. Test shall be completed within 30 days of installation or Substantial Completion, whichever is later.

END OF SECTION

SECTION 22 13 43 – FACILITY PACKAGED SEWAGE PUMPING STATIONS

1. GENERAL

1.1 SECTION INCLUDES

A. Wet-well, packaged pumping stations with submersible grinder sewage pumps

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. References.

B. Performance requirements.

1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within ± 10 percent of scheduled performance and published operating curve.

C. Submittals.

1. Detailed specifications.
2. Drawings with dimensions.
3. Parts List.
4. Pumps :

    a. Name of manufacturer.
    b. Type and model.
    c. Rotative speed.
    d. Size of suction nozzle.
    e. Size of discharge nozzle.
    f. Complete performance curves showing capacity versus head,
    g. NPSH required, pump and wire-to-water efficiency, and bhp.

5. Motors:

    a. Name of manufacturer.
    b. Type and model.
    c. Type of bearings and lubrication.
    d. Rated size of motor hp.
    e. Temperature rating.
    f. Full load rotative speed.
    g. Efficiency at full, 3/4, and 1/2 load.
    h. Full load current.

i. Locked rotor current.

6. Control Panel and components.

a. Name of manufacturer.
b. Type and model.
c. Dimensions and net weight of complete panel.
d. Overcurrent characteristics and details of motor control.

7. Operation and maintenance manuals for each type and size pump specified.

D. Operation and maintenance data.

E. Qualifications.

F. Delivery, storage and handling.

G. Extra materials.

1. Provide one set of mechanical seals and gaskets for each pump.

H. Warranty

1. Products included in this specification section shall have a 1-year warranty.

2. PRODUCTS

A. WET-WELL, PACKAGED PUMPING STATIONS WITH SUBMERSIBLE GRINDER SEWAGE PUMPS

1. See pump schedule on drawings for requirements.
2. Description: Factory fabricated, assembled, and tested with wet well for sewage pumps and collection of sanitary sewage and with suspended sewage pumps, controls, and accessories.
3. PU-6 and PU-7 REQUIREMENTS:

a. Scope: Furnish Stancor SG-500 or approved equivalent electric submersible grinder type wastewater pump(s) capable of delivering the scheduled design flow requirements. Pump shall include a 2” discharge. Each pump unit shall have 33_feet of power cable. The pump assembly shall have CSA U.S. 214705 approval.
b. Pump Design: The pump(s) shall be designed to handle, without clogging, clean water, contaminated water, wastewater effluent, storm water, and other similar corrosive liquids which may contain small solids. The pump shall have integrated feet allowing it to stand on a hard bottom wet well.

c. Pump Construction: Major pump components shall be of FC-20 Cast Iron with smooth surfaces devoid of porosity or other irregularities. All exposed fasteners shall be AISI type 316 stainless steel. Critical mating surfaces where a watertight seal is required shall be machined and fitted with NBR o-rings. Sealing will be the result of controlled compression of rubber o-rings without requiring a specific torque on fasteners to accomplish sealing. Rectangular cross sectioned gaskets requiring specific fastener torque to achieve compression shall not be considered adequate or equal. No secondary sealing compounds shall be used or required.

1) Impeller: The impeller shall be a non-clogging, dynamically balanced, semi-open grinder impeller with shredding ring design, capable of passing a 4 mm diameter spherical solid. The impeller shall have a precision machined slip fit onto the motor shaft and drive key, and shall be fastened to the shaft by a stainless steel impeller nut. The use of adjustable bottom plates to maintain efficiency shall not be considered equal.
2) Pump Volute: The pump volute shall be a single piece design with vertical discharge. Passages shall be smooth and large enough to pass any solids which may enter the impeller. Discharge flange design shall permit attachment to standard 2 " NPT pipe fittings.
3) Grinder Mechanism: The grinder mechanism shall consist of two circular, hardened cutter elements, one rotating and one stationary. The cutter material shall be of high Chrome Alloy with a hardness of Rockwell C 55-58. The rotating element shall be secured to the end of the pump shaft directly below the impeller by a stainless steel bolt which is mechanically prevented from loosening by a stainless steel nut. It shall be keyed to the impeller so that it rotates with the motor. The stationary element shall be secured to the cutter bracket and positioned so that it is concentric to and aligned with the rotating element. The stationary elements shall incorporate a vertical spline pattern at the grinding interface to create a shearing and cutting action between the elements as the rotating cutter spins. The rotating cutter shall incorporate an integrated solids deflector to prevent items such as plastic bags from covering the grinder assembly and starving the pump. All wastewater being pumped by the impeller shall be drawn through the grinder mechanism by the natural suction of the pump impeller and reduced to a particle size approximately 1/8 inch. The grinder mechanism shall not require routine adjustments throughout the life of the grinder assembly.
4) Shaft & Rotating Assembly: The common motor/pump shaft shall be of Stainless Steel-410 material that is in contact with pump's mechanical seals and shall have a polished finish and accurately machined shoulders to accommodate bearings, seals and impeller. Carbon steel shafts shall not be considered adequate or equal. The rotating assembly (impeller, shaft and rotor) shall be dynamically balanced such that undue vibration or other unsatisfactory characteristics will not result when the pump is in operation.
5) Triple Seal System: Each pump shall be equipped with a tandem mechanical shaft seal system consisting of two independent seal assemblies with a common spring between them and a radial lip seal; providing three complete levels of sealing between the pump wet end and the motor. The mechanical seals shall

operate in an oil filled chamber which is completely separate from the motor chamber. The seal faces shall be SiC/Sic for the lower seal and Carbon/Ceramic for the upper seal. Metallic components of the mechanical seal shall be constructed of 300 series stainless steel. The seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. A readily accessible inspection screw shall be provided for inspecting the condition of the seal chamber oil during routine maintenance.

6) Bearings: The pump shaft shall rotate on permanently lubricated, greased bearings. The upper bearing shall be a single row deep grooved ball bearing. The lower bearing shall be a heavy duty single row, deep grooved ball bearing. Upper and lower bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and minimize shaft deflection. B-10 bearing life shall be a minimum of 30k hr at BEP. Pump designs utilizing other than ball bearings, or those requiring supplemental guide bushings for the shaft or impeller shall not be considered acceptable.
7) Motor: The motor housing shall be FC-20 Cast Iron and the top cover of FC-20 Cast Iron. The motor shall be of the squirrel-cage induction design with copper windings, housed in an air filled, water tight chamber. The motor shall be capable of continuous submerged operation under water to a depth of 33 feet. The stator windings and stator leads shall be insulated with moisture resistant Class F insulation rated for 155 deg C (311 deg F). The motor shall be capable of operating continuously, submerged in liquid of 40 deg C (104 deg F) without overheating. The motor shall be capable of handling up to 10 evenly spaced starts per hour. All motors shall have a voltage tolerance of +/- 10% from nominal name plate rating.
8) Power Cable: The power cable shall be sized according to NEC and CSA standards and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be oil and water resistant thermoplastic elastomer. The power cable shall be fitted to the motor using an epoxy potted water tight cable entry system with a rubber grommet as the secondary seal and strain relief.

d. Factory provided rail system to allow for removal of pumps from tanks. Refer to Tank details on drawings for more information. Rail system to include (2) 2" cast iron discharge elbows with with internal check valves to allow removal of pump without disconnection of pipe.
e. Stancor m/n CB2002 3-phase duplex pump control panel.

1) UL 508A and UL 698A certified.
2) 16x14x7 NEMA 4X polycarbonate enclosure
3) IEC motor contactor.
4) Multi-tap transformer.
5) Motor protective switch (overload)
6) Alternator.
7) Green pump run indicator lights.
8) Alarm/control fuse.
9) Float switch terminal block.

10) Input power terminal block.
11) Ground lugs.
12) HOA (hand/off/auto) swtiches.
13) Standard alarm package:

a) High level relay for dry contacts
b) Indicator light for visual check
c) Sonalert audible alarm
d) Exterior alarm test with silence
e) Horn silence relay

14) Provide the following options:

a) High-water alarm
b) Mechanical float switches 20'-120' cords
c) Dry contacts for remote alarm signal
d) Door-mounted interlocking disconnects
e) High alarm dry contact

15) Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
16) Stancor m/n FLOAT 741-009-1-XXX mechanically-activated, narrow-angle float switch designed to activate pump control panels and alarms.

a) Cable: flexible 18 gauge 2 conductor (UL, CSA) SJOW, water-resistant
b) Float: 2.74 inch diameter x 4.83 inch long high impact, corrosion resistant, polypropylene housing for use in sewage and water up to 140 deg F.
c) Electrical: 5 amp, 125/250 VAC, 50/60Hz

4. PU-8 and PU-9 REQUIREMENTS:

a. Scope: Furnish Stancor SG-750 or approved equivalent stainless steel electric submersible non-clog wastewater pump(s) capable of delivering the scheduled design flow requirements. Pump shall include a 2" discharge. Each pump unit shall have 33_feet of power cable. The pump assembly shall have CSA U.S. 214705 approval.
b. Pump Design: The pump(s) shall be designed to handle, without clogging, clean water, contaminated water, wastewater effluent, storm water, and other similar corrosive liquids which may contain small solids. The pump shall have integrated feet allowing it to stand on a hard bottom wet well. The pump shall also be capable of mounting on a Guide Rail System allowing the pump to be removed from the wet well without disturbing the discharge piping or requiring personnel to enter the wet well.

c. Pump Construction: Major pump components shall be of AISI type 316 stainless steel with smooth surfaces devoid of porosity or other irregularities. All exposed fasteners shall be AISI type 316 stainless steel. Critical mating surfaces where a watertight seal is required shall be machined and fitted with FKM o-rings. Sealing will be the result of controlled compression of rubber o-rings without requiring a specific torque on fasteners to accomplish sealing. Rectangular cross sectioned gaskets requiring specific fastener torque to achieve compression shall not be considered adequate or equal. No secondary sealing compounds shall be used or required.

1) Impeller: The impeller shall be a non-clogging, dynamically balanced, vortex design, capable of passing a 45mm diameter spherical solid. The impeller shall have a precision machined slip fit onto the motor shaft and drive key, and shall be fastened to the shaft by a stainless steel impeller nut. The use of adjustable bottom plates to maintain efficiency shall not be considered equal.
2) Pump Volute: The pump volute shall be a single piece design with vertical discharge. Passages shall be smooth and large enough to pass any solids which may enter the impeller. Volute inlet opening shall be 65mm. Flanged Discharge design shall permit attachment to standard 3” or 4” NPT pipe fittings or optional guide rail system.
3) Shaft & Rotating Assembly: The common motor/pump shaft shall be of AISI type 316 stainless steel material that is in contact with pump’s mechanical seals and shall have a polished finish and accurately machined shoulders to accommodate bearings, seals and impeller. Carbon steel shafts shall not be considered adequate or equal. The rotating assembly (impeller, shaft and rotor) shall be dynamically balanced such that undue vibration or other unsatisfactory characteristics will not result when the pump is in operation.
4) Triple Seal System: Each pump shall be equipped with a tandem mechanical shaft seal system consisting of two independent seal assemblies with a common spring between them and a radial lip seal; providing three complete levels of sealing between the pump wet end and the motor. The mechanical seals shall operate in an oil filled chamber which is completely separate from the motor chamber. The seal faces shall be SiC/Sic for the lower seal and Carbon/Ceramic for the upper seal. Metallic components of the mechanical seal shall be constructed of 300 series stainless steel. The seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. A readily accessible inspection screw shall be provided for inspecting the condition of the seal chamber oil during routine maintenance.
5) Bearings: The pump shaft shall rotate on permanently lubricated, greased bearings. The upper bearing shall be a single row deep grooved ball bearing. The lower bearing shall be a heavy duty single row, deep grooved ball bearing. Upper and lower bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and minimize shaft deflection. B-10 bearing life shall be a minimum of 30k hr at BEP. Pump designs utilizing other than ball bearings, or those requiring supplemental guide bushings for the shaft or impeller shall not be considered acceptable.
6) Motor: The motor housing and top cover shall be AISI type 316 stainless steel. The motor shall be of the squirrel-cage induction design with copper windings,

housed in an air filled, water tight chamber. The motor shall be capable of continuous submerged operation under water to a depth of 33 feet. The stator windings and stator leads shall be insulated with moisture resistant Class B insulation rated for 130 deg C (266 deg F). The motor shall be capable of operating continuously, submerged in liquid of 40deg C (104 deg F) without overheating. The motor shall be capable of handling up to 10 evenly spaced starts per hour. All motors shall have a voltage tolerance of +/- 10% from nominal name plate rating.

7) Power Cable: The power cable shall be sized according to NEC and CSA standards and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be oil and water resistant thermoplastic elastomer. The power cable shall be fitted to the motor using an epoxy potted water tight cable entry system with a rubber grommet as the secondary seal and strain relief.

d. Factory provided rail system to allow for removal of pumps from tanks. Refer to Tank details on drawings for more information. Rail system to include (2) 2" cast iron discharge elbows with with internal check valves to allow removal of pump without disconnection of pipe.

e. Stancor m/n CB2000 3-phase simplex pump control panels. One panel for each pump.

1) UL 508A and UL 698A certified.
2) 14x7x2 NEMA 4X polycarbonate enclosure
3) IEC motor contactor.
4) Multi-tap transformer.
5) Motor protective switch (overload)
6) Green pump run indicator lights.
7) Alarm/control fuse.
8) Float switch terminal block.
9) Input power terminal block.
10) Ground lugs.
11) HOA (hand/off/auto) swtiches.
12) Standard alarm package:

a) Indicator light for visual check
b) Sonalert audible alarm
c) Exterior alarm test with silence
d) Horn silence relay

13) Provide the following options:

a) High-water alarm with red LED light, buzzer and test-silence switch.
b) Mechanical float switches with 20'-60' cords
c) Dry contacts for remote alarm signal
d) High alarm dry contact

14) Control Sequence of Operation: Cycle pump on and off automatically to maintain wet-well sewage level. Automatic control operates pump if wet-well level rises above starting point of low-level pump, until shutoff level is reached.
15) Stancor m/n FLOAT 741-009-1-XXX mechanically-activated, narrow-angle float switch designed to activate pump control panels and alarms.

a) Cable: flexible 18 gauge 2 conductor (UL, CSA) SJOW, water-resistant
b) Float: 2.74 inch diameter x 4.83 inch long high impact, corrosion resistant, polypropylene housing for use in sewage and water up to 140 deg F.
c) Electrical: 5 amp, 125/250 VAC, 50/60Hz

5. Biowaste Tanks:

a. Description: Precast vault structure and lid. See Biowaste Tank details on drawings for more information.
b. 5600 gal tank made of ASTM C478 4000 PSI concrete minimum with 0.45 maximum water/cementitious materials ratio.

1) Reinforcing fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
2) Reinforcing bars: ASTM A 615/A 615M, Grade 60 deformed steel.
3) ConShield with CONTINT shall be added to all precast and cast-in-place manholes in accordance with manufacturer's recommendations.

a) Cast-in-place concrete invert fill and collars inside the manhole shall contain ConShield with CONTINT per manufacturer's recommendation.

c. Base section:

1) Floor slab: 8 inch thick, unless otherwise indicated on drawings.
2) Walls: 6 inch thick, unless otherwise indicated on drawings.
3) Base riser section: 6 inch thick, unless otherwise indicated on drawings.

d. Riser section:

1) 48 inch diameter unless otherwise indicated on drawings, with 6 inch thick walls.

e. Top section: Concentric cone, eccentric cone, or flat slab type, as indicated on drawings.

1) Top of cone to match grade rings.

f. Grade rings: Reinforced concrete rings, 4 to 9 inches thick.
g. Gasket: O-ring, double ring, or preformed bitumastic sealant.

h. Steps: Steel reinforced polypropylene plastic steps per ASTM 4101, cast into base, riser and top sections at 12 inches intervals.
i. Frame and cover: ASTM A48, Class 35 gray iron.

1) Frame size: 24 inch inside diameter, by 9 inch riser with 4 inch width flange.
2) Cover: 26 inch diameter, indented top design, with lettering “SANITARY SEWER” cast into cover.

j. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
k. Pipe connectors: ASTM C923, resilient type.

1) Provide “boot” type nitrile rubber connections at locations indicated on Drawings.

l. Interior of tank to be coated with Duralkote 500 epoxy coating applied in field after installation.

3. EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings.

D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.3 START-UP AND COMMISSIONING

A. Before and after start-up, perform the following preventative maintenance operations and checks:

1. Lubricate bearings.

2. After pump is started, check for proper rotation, proper mechanical operation and motor load to ensure that pump is not overloaded. Close pump balancing valve as required to bring pump motor load within motor nameplate data.
3. Check pumps to ensure it is not air bound or cavitating.
4. After completing start-up, replace pump strainer with permanent strainer.

B. Engage a factory-authorized service representative to perform startup service.

1) Complete installation and startup checks according to manufacturer's written instructions.
2) Adjust pump, accessory, and control settings, and safety and alarm devices.

END OF SECTION

SECTION 22 21 23
PLUMBING PUMPS

1. GENERAL

1.1 SECTION INCLUDES

A. In-line wet rotor circulation pumps for potable water systems.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. References.

B. Performance requirements.

1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within ± 10 percent of scheduled performance and published operating curve.

C. Submittals.

D. Operation and maintenance data.

E. Qualifications.

F. Delivery, storage and handling.

G. Extra materials.

2. PRODUCTS

A. IN-LINE WET ROTOR CIRCULATION PUMPS FOR POTABLE WATER SYSTEMS

B. See Plumbing Pumps Schedule on drawings for performance requirements.

C. The contractor shall furnish and install in-line circulating pumps as illustrated on the plans and in accordance with the following specifications:

1. The pumps shall be a wet rotor inline pump, in cast iron or lead free stainless steel body construction specifically designed for quiet operation. Suitable standard operations at

230° F and 175 PSIG working pressure. The pump internals shall be capable of being serviced without disturbing piping connections.

2. The pump internals shall be capable of being serviced without disturbing piping connections.
3. Pump shall be equipped with a water-tight seal to prevent leakage.
4. Pump volute shall be of a cast iron design for heating systems or lead free stainless steel for domestic water systems. The connection style on the cast iron and stainless steel pumps shall be flanged.
5. Flange to Flange dimension shall be standard Bell & Gossett booster sizes such as 6-3/8", 8-1/2", 11-1/2", and 12". Flange dimensions shall be HVAC industry standard 2 or 4 bolts sizes.
6. Motor shall be a synchronous, permanent-magnet (PM) motor and tested with the pump as one unit. Conventional induction motors will not be acceptable.
7. Each motor shall have an Integrated Variable Frequency Drive tested as one unit by the manufacturer.
8. Integrated motor protection shall be verified by UL to protect the pump against over/under voltage, over temperature of motor and/or electronics, over current, locked rotor and dry run (no load condition).
9. Pump shall have MODBUS or BACnet connections built into the VFD as standard options.
10. Analog inputs, such as 0-10V and 4-20mA, are standard inputs built into the VFD.
11. Pumps shall be UL 778 listed and bear the UL Listed Mark for USA and Canada with on-board thermal overload protection.
12. Pumps shall be UL 778 listed and bear the UL Listing Mark for USA and Canada with on-board thermal overload protection.
13. Each pump shall be factory performance tested before shipment.

3. EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings.

D. Provide line sized shut-off valve and pump suction fitting flexible connection on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.

E. Install valves that are the same size as piping connected to pumps.

F. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

3.3 START-UP AND COMMISSIONING

A. Start-up pump in accordance to manufacturer written instructions.

B. Do not start pump until the system has been filled and vented. Air should be vented from the system by means of an air vent located at a high point in the system. The system must be completely vented prior to pump operation. Do not run circulators dry. Pump operation without water circulation could result in pump and motor damage.

C. Coordinate pump testing, adjusting and balancing with Balancing Contractor. Complete additional preliminary work required by Balancing Contractor.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 30 00 - PLUMBING EQUIPMENT

1. GENERAL

1.1 SECTION INCLUDES

A. Water heaters

B. Thermal mixing valves.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Submittals

1.3 QUALITY ASSURANCE

A. See Section 22 05 00.

B. Perform Work in accordance with State and Local standards.

C. Ensure products and installations of specified products are in conformance with recommendations and requirements of the following organizations:

1. National Sanitation Foundation (NSF).
2. American Society of Mechanical Engineers (ASME).
3. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
4. National Electrical Manufacturers' Association (NEMA).
5. Underwriters Laboratories (UL).

2. PRODUCTS

2.1 Refer to Plumbing Equipment Schedules for performance requirements.

2.2 WATER HEATER

A. The water heater shall be a Lochinvar Shield series or approved equal having a maximum input rating and recovery capacity equal to what is shown in schedule on drawings and shall be operated on Natural Gas. The water heater shall be capable of full modulation firing down to 20% of rated input with a 5:1 turndown ratio

B. The water heater shall consist of a direct fired Stainless Steel heat exchanger mounted on top of a glass lined storage tank in a fashion that will reduce the amount of scale build-up that is known to reduce efficiency. The water heater shall have no visible pipes that connect the heat exchanger to the storage tank. There shall be no banding material, bolts, gaskets or "O" rings in the construction of the heat exchanger header. The Stainless Steel combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly. A built-in trap shall allow condensation to drain from the heat exchanger assembly. The water heater shall carry a three (3) year heat exchanger and tank warranty and a one (1) year parts warranty.

C. The tank shall have a working pressure of 150 psi. The tank shall be glass lined and fired to 1600°F to ensure a molecular fusing of glass and steel. The tank shall be completely encased in high density insulation of sufficient thickness to meet the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The tank shall be fitted with a brass drain valve.

D. The water heater shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.10.3 test standard for the US and Canada. The water heater shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 standard. The water heater shall be certified for indoor installation. The water heater's efficiency shall be verified through third party testing by AHRI and listed in the AHRI Certification Directory.

E. The water heater shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The water heater shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating firing rates for maximum efficiency. The water heater shall operate in a safe condition at a de-rated output with gas supply pressures as low as 4 inches of water column.

F. The water heater shall utilize a 24 VAC control circuit and components. The control system shall have an electronic display for setup, status and diagnostics. All electronic circuitry shall be easily accessed and serviceable from the front of the jacket. The water heater shall be equipped with; a circulating pump; high limit temperature control; ASME certified temperature and pressure relief valve; inlet & outlet water temperature sensors; flue temperature sensor; runtime contacts; alarm contacts; low water flow protection, contacts for louvers, security protection, adjustable pump delay, enable/disable contacts and built-in freeze protection. The control shall have optional capability to communicate via Modbus or BACnet protocol and capability for optional CON-X-US remote connectivity. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory operation test prior to shipping.

G. The water heater shall feature the smart control platform with pump delay, freeze protection, pump exercise and Start-Up Wizard operating with an LCD display and soft key pad. The water heater shall be equipped with an eight foot power cord. Supply voltage shall be 120 volt / 60 hertz / single phase.

H. The water heater shall be installed and vented with a direct vent vertical system with a vertical roof top termination of both the vent and combustion air. The flue shall be CPVC, Polypropylene or Stainless Steel sealed vent material terminating at the roof top with the manufacturers specified vent termination. A separate pipe shall supply combustion air directly to the water heater from the outside. The air inlet pipe may be PVC, CPVC, Polypropylene, ABS, Galvanized, Dryer Vent, or Stainless Steel sealed pipe. The air inlet must terminate on the roof top with the manufacturer's specified air inlet cap. The total combined air intake length shall not exceed 150 equivalent feet. The total combined exhaust venting length shall not exceed 150 equivalent feet. Foam Core pipe is not an approved material for exhaust piping.

I. The water heater shall be approved for 180°F operation. The water heater shall have an independent laboratory rating for Oxides of Nitrogen (NOx) of 20 ppm or less, corrected to 3% O2. The water heater shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments.

J. Maximum unit dimensions shall be: Width 34 inches and Height 80 inches. Maximum unit weight shall be 850 pounds.

K. The Firing Control System shall be M9, Direct Spark Ignition with Electronic Supervision.

2.3 THERMAL MIXING VALVES

A. Refer to Plumbing Equipment Schedule for performance requirements.

B. Manufacturer: Subject to compliance with scheduled requirements, provide product by one of the following:

1. Powers
2. Armstrong International, Inc.
3. Leonard Valve Company
4. Or equivalent.

C. Digital mixing valve with check stops, integral RTD sensor, return piping assembly.

D. 1-1/4" inlets, 1-1/2" outlet, 1" return

E. 0.25 GPM minimum flow capacity

F. Maximum operating pressure: 125 PSIG.

G. +/- 2 deg F water temperature control per ASSE 1017.

H. Automatic hot/cold water shutoff upon cold/ho water inlet supply failure.

I. User programmable setpoint range between 65 deg F and 180 deg F.

J. UL listed control box.

K. UL listed 120V plug in power supply with 6’ cord.

L. Factory assembled and tested.

3. EXECUTION

3.1 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain plumbing equipment.

3.2 WATER HEATER INSTALLATION

A. Install new and relocated water heaters in accordance with manufacturer's instructions.

B. Following manufacturer’s instructions for piping the (2) water heaters in parallel and provide all required fittings, accessories, components, etc. to allow for a fully functional system.

3.3 THERMAL MIXING VALVE INSTALLATION

A. Install thermal mixing valve in accordance with manufacturer's instructions.

A. Equipment Mounting: Install thermal mixing valve on 2” uni-strut.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Install thermal mixing valve and fittings furnished by equipment manufacturer but not specified to be factory installed.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturers written instructions.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 40 00
PLUMBING FIXTURES

1. GENERAL

1.1 SECTION INCLUDES

A. Installation requirements of plumbing fixtures scheduled in Plumbing Fixture Schedule.

B. Plumbing fixture carriers.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Submittals

C. Quality Assurance

D. Delivery, Storage and Handling

1.3 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings and instructed by the manufacturer.

B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks.

2. PRODUCTS

2.1 PLUMBING FIXTURES

A. Refer to Plumbing Fixture, Accessory, and Connection Schedule on drawings for all required product information.

1. Water closets shall be vitreous china construction, wall mounted, 1.6 gallon flush, white with white seats unless scheduled otherwise.

a. Acceptable manufacturer for water closets are Kohler, Sloan, Zurn and American Standard.

b. Flush valves shall be sensor-operated, hardwired, with 1” connection. Acceptable manufacturers are Zurn, Slan and AMTC.

2. Lavatories

a. Faucets shall be sensor operated, battery powered, and serviceable from above the sink. Acceptable manufacturers are Zurn and Sloan.
b. Sink: Elkay Stainless Steel 22" x 19" x 5-1/2" Wall Hung Lavatory Sink or approved equal. Sink is manufactured from 18 gauge 304 Stainless Steel with a Buffed Satin finish, Rear Center drain placement, and Bottom only pads.

3. Laboratory sinks

a. See Plumbing Fixture, Accessory, and Connection Schedule.

4. Scullery sinks

a. See Plumbing Fixture, Accessory, and Connection Schedule.
b. Sink: Just Mfg or equivalent stainless steel 96" x 27-1/2" x 14" Floor Mount Double Scullery Sink w/L&R Drainboards Coved Corners. Sink shall be manufactured from 14 gauge 304 Stainless Steel with a Buffed Satin finish, Center drain placement.
c. Faucet: Just Mfg m/n JPR-309 or equivalent.

1) Exposed wall or backsplash mount on 8 inch centers
2) 44" stainless steel hose with rubber interior
3) Brass mixing faucet has 1/2" flanged union inlets
4) Integral ball checks in faucet prevents water cross flow
5) Handles are fully open in less than 1/2 turn
6) Wall bracket assembly for secure installation included
7) Flowrate: 1.6 GPM
8) Compliant with:

a) NSF/ANSI 61/9- Annex G
b) AB1953
c) ANSI A112.18.1 / CSA B125.1

9) Finish: Polished chromeplate

5. Mop sinks

a. See Plumbing Fixture, Accessory, and Connection Schedule.
b. Manufactured by Stern-Williams Co., Inc.or equivalent. Shoulders shall not be less than 9-3/4" high inside measurement, and not less than 1-1/4" wide. Tiling flange, cast integral, shall extend 1" above shoulder on 1,2 or 3 sides (as job required).

Drain shall be cast brass with stainless steel strainer cast integral and shall provide for a caulked lead connection not less than 1" deep to a 3" pipe. Receptor composed of pearl grey marble chips and white Portland cement ground smooth, grouted and sealed to resist stains. Stainless steel cap of one piece 20 ga. 302 stainless steel cast integral on all four sides.

6. Showers

a. See Plumbing Fixture, Accessory, and Connection Schedule.
b. Complete commercial shower system includes: an R120SS pressure balance valve and trim, a wall supply with 1/2" NPT female inlet and 1/2" NPSM male outlet, a 59" (1500mm) metal shower hose, vacuum breaker, a “Fixed” personal shower, and a 36" Slide Bar. Valve features a cast brass body, washerless 47mm ceramic disc valve cartridge with volume and temperature control and hot limit safety stop. Pressure balancing cartridge maintains constant output temperature in response to changes in relative hot and cold supply pressure. One-half inch direct sweat inlets and outlets. With screwdriver stops. Durable metal handle. Rough-in plaster guard designed for use as thin-wall mounting adaptor. Fixed hand shower with 2.5gpm/9.5L/min. flow restrictor. Slide bar features an adjustable shower holder which can be set at any height or position along the bar and angle up to 45˚.

2.2 PLUMBING FIXTURE CARRIERS

A. All wall mounted fixtures such as water closets, lavatories, etc. shall be installed with compatible carriers. All carriers shall be commercial or industrial grade and shall be suitable for the fixture served, space available and building construction. All carriers shall extend to the floor and be anchored into the slab.

B. Water closet carriers shall be heavy-duty type, rated for a minimum of 750 lbs.

3. EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

C. Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install each fixture with trap with 2 slip joints, easily removable for servicing and cleaning.

C. Provide chrome plated rigid or flexible supplies to fixtures with stops, reducers, and escutcheons.

D. Install components level and plumb.

E. Install and secure fixtures in place with scheduled wall supports or wall carriers and bolts.

F. Seal fixtures to wall and floor surfaces with sealant, color to match fixture.

3.4 WATER CLOSET INSTALLATION

a. Water-Closet Installation:

1) Install level and plumb according to roughing-in drawings.

2) Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1. Coordinate exact locations with drawings.
3) Where installing piping adjacent to water closets, allow space for service and maintenance.

b. Support Installation:

1) Use carrier supports with waste-fitting assembly and seal.
2) Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

c. Flushometer-Valve Installation:

1) Install flushometer-valve, water-supply fitting on each supply to each water closet.
2) Attach supply piping to supports or substrate within pipe spaces behind fixtures.

3) Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4) Install actuators in locations that are easy for people with disabilities to reach.

d. Install toilet seats on water closets.
e. Wall Flange and Escutcheon Installation:

1) Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2) Install deep-pattern escutcheons if required to conceal protruding fittings.

f. Joint Sealing:

1) Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2) Match sealant color to water-closet color.

3.5 LAVATORY AND SINK INSTALLATION

A. Install lavatories and sinks level and plumb according to roughing-in drawings.

a. Install supports, affixed to building substrate, for wall-mounted lavatories and sinks.

b. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1. Coordinate exact locations with drawings.
c. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.
d. Seal joints between lavatories/sinks, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

e. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks.
f. Install water-supply piping with stop on each supply to each faucet.

1) Exception: Use ball, gate, or globe valves if supply stops are not specified with lavatory/sink.
2) Install stops in locations where they can be easily reached for operation.

3.6 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.7 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

B. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

C. Adjust water pressure at flushometer valves to produce proper flow.

D. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.8 CLEANING

A. Directly prior to project turnover, clean plumbing fixtures and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets, urinals, and fittings.

C. Do not allow use of plumbing fixtures for use during construction unless approved in writing by Owner.

END OF SECTION

SECTION 22 67 00
REVERSE OSMOSIS (RO) WATER PIPING

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe and pipe fittings.

B. Valves.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

1. Include functional data, operational procedures, maintenance procedures, and servicing instruction, and other information required in Section 22 05 00 for Maintenance Manuals.
2. Completed pipe pressure test report.

E. Project record documents.

1. Record actual locations of valves.

F. Delivery, storage, and handling.

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with International Plumbing Code and all manufacturer recommendations.

2. PRODUCTS

2.1 REVERSE OSMOSIS (RO) WATER PIPING, ABOVE GRADE

A. At contractor's option, one of the following systems shall be installed:

1. Polypropylene Piping System: Pipe manufactured to ASTM D1785 for dimensions and tolerances. Material shall be natural virgin copolymer polypropylene with no added plasticizers, pigments, or re-grind that meets the requirements of ASTM D4101 and is compliant with FDA 21.CFR 177.1520 Sections A1, B and C. Pipe shall be packaged in polybags at the point of manufacturing to preserve cleanliness.

   a. Fittings: Fitting material shall be of same type as pipe material. Fittings shall be designed for socket fusion utilizing manufacturer's recommended fusion tools and shall have a design working pressure of 150 psig at 68°F. Fittings shall be packaged in polybags at the point of manufacturing to preserve cleanliness.
   b. Joints: Socket fusion joints. Note that mechanical joints are not allowed.
   c. Joining Method: Electric coil fusion (electrofusion) or heat plate socket fusion. Note that if electrofusion is not used, the controller/heater shall be a bench machine with integral provisions for ensuring proper alignment and joint depth. Hand-held controller/heaters are not acceptable.
   d. Valves: Material shall be natural virgin copolymer polypropylene with no added plasticizers, pigments, or re-grind that meets the requirements of ASTM D4101 and is compliant with FDA 21.CFR 177.1520 Sections A1, B and C. Valves shall be designed for socket fusion utilizing manufacturer's recommended fusion tools and shall have a design working pressure of 150 psig at 68°F.

      1) Ball valves shall have two-way blocking capability, blow-out proof stem with double seals, FPM O-rings, PTFE valve seats, and elastomeric backing. Ball shall be full bore type. Valves shall be packaged in polybags at the point of manufacturing to preserve cleanliness.
      2) Diaphragm Valves: Diaphragm valves shall be constructed of PP with EPDM seal configurations, manufactured for installation in manufacturer's system. Valves shall be packaged in polybags at the point of manufacturing to preserve cleanliness.
      3) Check Valves: Check Valves shall be constructed of PVDF available in EPDM seal configurations manufactured for installation in manufacturer's system. Valves shall be packaged in polybags at the point of manufacturing to preserve cleanliness.

   e. Manufacturers: Subject to compliance with all specified requirements, provide products by:

      1) PPro-Seal by George Fischer Sloane.
      2) Enpure by IPEX.
      3) Approved equivalent.

2. PVC Low Extractable High Purity Piping System

a. General: UPW process piping and fittings shall be manufactured from a specialty low-extractable, Polyvinyl Chloride (PVC) compound with a Cell Classification of 12343 per ASTM D1784. All pipe and fittings shall be produced to Schedule 80 dimensions, manufactured in strict compliance to ASTM D1785 (pipe), and ASTM D2467 (fittings). These products shall carry a Type II pressure rating and consistently meet or exceed the applicable Quality Assurance test requirements of these standards with regard to dimensions, workmanship, burst pressure, flattening resistance and end-product quality. All UPW process valves shall be True Union-style diaphragm or True Union-style quarter-turn ball valves produced from the same low-extractable PVC compound. All valve diaphragms and seats shall be PTFE; valve O-rings shall be EPDM or FKM as applicable. All valve union nuts shall have buttress-style threads. All valve components shall be replaceable. System components shall be joined utilizing Spears® One-Step specialty solvent cement specifically formulated for joining the system that meet or exceed the requirements of ASTM D2564. All system components shall be manufactured in the USA by an ISO-certified manufacturer. All UPW piping and fittings shall be bagged and sealed immediately after manufacture to maintain cleanliness, and boxed and stored indoors at the manufacturing facility until shipped from the factory. UPW process pipe, fittings, valves and cement shall be that as manufactured by Spears® Manufacturing Company.

1) Fitting Product Description: UPW process fittings shall be manufactured from a specialty low-extractable, Polyvinyl Chloride (PVC) compound with a Cell Classification of 12343 per ASTM D1784. All fittings shall be produced to Schedule 80 dimensions, manufactured in strict compliance to ASTM D2467. All fittings shall be bagged and sealed immediately after manufacture to maintain cleanliness, and boxed and stored indoors at the manufacturing facility until shipped from the factory.
2) Pipe Product Description: UPW process piping shall be manufactured from a specialty low-extractable, Polyvinyl Chloride (PVC) compound with a Cell Classification of 12343 per ASTM D1784. All pipe shall be produced to Schedule 80 dimensions, manufactured in strict compliance to ASTM D1785. All piping shall be bagged and sealed immediately after manufacture to maintain cleanliness, and boxed and stored indoors at the manufacturing facility until shipped from the factory.
3) Valve Product Description: All UPW process valves shall be True Union-style diaphragm or True Union-style quarter-turn ball valves produced from a specialty low-extractable, Polyvinyl Chloride (PVC) compound with a Cell Classification of 12343 per ASTM D1784. All valve diaphragms and seats shall be PTFE; valve O-rings shall be EPDM or FKM as applicable. All valve union nuts shall have buttress-style threads. All valve components shall be replaceable. All Valves shall be bagged and sealed immediately after manufacture to maintain cleanliness, and boxed and stored indoors at the manufacturing facility until shipped from the factory.
4) Pipe, Fittings, and Valves: Pipe, fitting and valve material shall meet or exceed the requirements of ASTM D1784.

5) Solvent Cement: System components shall be joined utilizing Low Extractable One-Step specialty solvent cement specifically formulated for joining the system that meet or exceed the requirements of ASTM D2564. The standard practice for safe handling of solvent cements shall be in accordance with ASTM F402. Solvent cement shall be NSFcertified for potable water.

6) Manufacturer: The system fittings, piping and valves shall be manufactured from a specialty low extractable PVC compound and supplied by Spears® Manufacturing Company.

B. Piping to be installed upstream/downstream of UV filter (See 3. EXECUTION paragraph):

1. Stainless Steel Pipe: Schedule 10, ASTM A312/A312 M, Grade TP316L, seamless pipe.

a. Fittings: ASTM A 403/A 403M, Class S, seamless fittings matching pipe thickness and grade.
b. Joints: Welded.

C. Supports: All pipe supports shall use the pipe manufacturer's recommended support system. Support spacing shall be in accordance with the manufacturer's written instructions and recommendations.

D. In return air plenum applications, polypropylene RO Water piping must be fully insulated with 3M Fire Barrier Plenum Wrap 5A or equivalent fire wrap system. All damage to fire wrap system must be repaired in accordance with manufacturer recommendations to provide a completely protected system.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Route piping in orderly manner and install level and plumb.

C. Install piping to conserve building space and not interfere with use of space.

D. Install hangers spaced as recommended by manufacturer, but free from sags or bends in system.

E. Install padded hangers and support rods spaced as recommended by manufacturer, but in no case less than:

1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
3. NPS 2-1/2 and NPS 3: 48 inches with 1/2-inch rod.

F. Install padded supports for vertical piping NPS 2-1/2 and larger every 120 inches and midstory for NPS 2 and smaller.

G. Group piping whenever practical at common elevations.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. RO piping installation shall only be performed by factory trained and certified installers in accordance with the manufacturer's written procedures. Each installer shall complete the manufacturer's certification course, including written test examinations and submittal of test fusion welds to the factory for evaluation and file. Installation practices, including support spacing and expansion considerations, shall be in accordance with the manufacturer's certification course and written recommendations.

1. The manufacturer shall also provide training and certification for Owner's personnel at a time separate from the contractor training. Coordinate exact time with Owner.
2. Installer shall adhere to all manufacturer requirements for preheating and fusion times in cold weather.
3. Fuse seal piping: Upon completion of the project, the contractor shall send electrofusion controller/heater (used on polypropylene pipe) back to factory for calibration and necessary repairs prior to delivering to the Owner. Contractor shall be responsible for any expense accrued due to the recertification and repair of the electrofusion controller/heater. Contractor shall also provide all associated components required to maintain the piping system.

J. Provide clearance for access to valves and fittings.

K. Provide access where valves and fittings are not exposed.

L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

M. Install valves with stems upright or horizontal, not inverted.

N. Use of FPT Polypropylene fittings shall be kept to a minimum. When used, FTP fittings shall be reinforced with a stainless steel hose clamp once threaded together.

O. Install stainless steel pipe and fittings upstream and downstream of RO Water system ultraviolet sterilizer to protect RO water piping from excess sterilizer light. Transition to specified RO water

pipe and fittings for remainder of system. See drawings for further information.

3.2 APPLICATION

A. Install polypropylene and PVC flanges with backing rings downstream of valves and at equipment or apparatus connections. As an alternative, valves can be used as unions if valve is specifically designed with union ends.

B. Flanged joints, where required, shall be installed per piping manufacturers' recommendations using full-face, 1/8-inch thick, EPDM flange gasket. Install and torque stainless steel bolts per piping manufacturers' recommendations.

C. Install ball or diaphragm valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Install ball or diaphragm valves for throttling, bypass, or manual flow control services.

E. Provide spring loaded check valves on discharge of water pumps.

3.3 PIPING SYSTEM PRESSURE TESTING

A. Submit copy of Pipe Pressure Test Log provided in section 22 05 00 for each section of piping tested.

B. System to be hydrostatic tested using RO water at one and a half times the intended working pressure of the system, not to exceed the maximum working pressure of any single component in the system. All air must be evacuated from the piping system at high points and pressure brought up slowly as to not create hydraulic shock. Inform Owner's Representative a minimum of 2 weeks in advance of pressure test. Note that the use of air or other compressed gases will not be allowed for pressure testing of RO Water piping.

C. Leave uncovered and unconcealed all new, altered, extended, or replaced piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

3.4 PIPE SYSTEM CLEANING

System cleaning shall be completed by the Water Purification System equipment manufacturer. See Section 22 67 01.

END OF SECTION

SECTION 22 67 01
WATER PURIFICATION SYSTEM EQUIPMENT

1. GENERAL

1.1 SECTION INCLUDES

A. Water purification system equipment.

1.2 RELATED SECTIONS

A. Section 22 67 00 – Reverse Osmosis Water Piping.

1.3 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. References

B. Submittals

C. Operation and maintenance manuals.

1. Include functional data, operational procedures, maintenance procedures, and servicing instruction, and other information required in Section 22 05 00 for Maintenance Manuals.
2. Include warranty information as specified within this section.
3. Include inspection report completed by factory-authorized service representative.
4. Include certified sampling test reports for required water performance characteristics.

1.4 QUALITY ASSURANCE

A. See Section 22 05 00.

B. Perform Work in accordance with State and Local standards.

C. Provide pumps with manufacturer's name, model number, and rating/capacity identified.

1.5 WARRANTY

A. Provide written three-year warranty from the date of Substantial Completion for repair or replacement of pure water equipment components that fail in materials or workmanship.

2. PRODUCTS

2.1 Refer to Water Purification Equipment Schedule on Drawings for performance requirements.

2.2 All water purification system equipment components shall be provided as part of a package by a single manufacturer. Subject to compliance with the specified requirements, manufacturers offering products that may be incorporated into the package include, but are not limited to:

A. Culligan (Basis of Design)

B. Siemens.

C. Millipore.

D. US Filter.

E. Or approved equivalent.

2.3 All required system components required to produce the quality and quantity of water listed in the equipment schedule on the drawings shall be provided by the pure water system equipment manufacturer. There shall be no requirement for the Owner to lease any items, such as deionization tanks, carbon filter tanks, etc.

3. EXECUTION

3.1 WATER PURIFICATION SYSTEM EQUIPMENT INSTALLATION

A. Engage a manufacturer-authorized installer to install all water purification equipment and interconnecting piping.

B. Install all components in accordance with manufacturer's instructions.

C. Anchor tanks and floor-mounted equipment to substrate.

D. Pipe relief valves and drains to nearest floor drain.

E. All piping upstream of reverse osmosis unit shall be considered domestic soft cold water. Install per Section 22 10 00.

F. All piping downstream of reverse osmosis shall be considered RO water and shall be install per Section 22 67 00.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Engage a factory-authorized service representative to inspect field assembly of components and electrical connections. Report results in writing.

B. Testing:

1. After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist. See Section 22 67 00 for testing requirements.
2. After water purification system equipment and interconnecting piping has been leak-tested, the water purification system equipment supplier shall clean the system loop piping, components, and storage tank by circulating a solution of chlorine dioxide and water, in concentration recommended by manufacturer, for a minimum of 2 hours. During circulation, all valves and faucets shall be opened at some point as necessary to clean all portions of the system. Then, rinse with reverse osmosis system purified water and test for chlorine dioxide level to ensure no residue remains. If residue remains, repeat rinse and retest cycle until all components and piping are free of residue.
3. After electrical connections have been energized, start system and confirm proper operation of all components. Remove malfunctioning units, replace with new units, and retest.
4. Replace damaged or malfunctioning controls and equipment.

C. Sampling:

1. Sample effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics.

D. Contractor Coordination

1. The manufacturer and contractor shall coordinate all work to ensure a fully functional and leak-free system. Permanent labeling shall be provided at the demarcation point between the water piping (domestic soft cold water piping and RO water piping) installed by the Contractor and the water purification system equipment/piping installed by the manufacturer to indicate the responsible party (manufacturer or contractor) for all portions of work in the event of future leaks outside of the warranty period.
2. All water purification system equipment components shall be properly labeled with serial numbers, part numbers, and contact information.

3.3 COMMISSIONING

A. Engage a factory-authorized service representative for a minimum of 16 hours to supervise construction and to perform startup service.

END OF SECTION

SECTION 23 05 00
BASIC HVAC REQUIREMENTS

1. GENERAL

1.1 SECTION INCLUDES

A. This section describes Basic Mechanical Requirements to provide for a complete installation of all mechanical systems for this project. This section shall apply to all other Division 23 specification sections as well as all work shown on the drawings.

B. It is the intent of the Mechanical Division of the Specifications that all mechanical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations operate as designed.

C. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's representative.

D. The Contractor shall note that, in some cases, piping as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference-free systems with proper clearance to facilities and equipment.

E. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.

F. Note that the words "mechanical" and "plumbing" are used interchangeably throughout the Division 22 and 23 specification sections.

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section and all other sections of Division 23.

1.3 DESCRIPTION OF WORK

A. The work included under this section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete mechanical systems required by these specifications and/or shown on the drawings of the contract.

B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, piping fixtures, etc. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.

1.4 QUESTIONS OF INTERPRETATION

A. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Architect/Engineer for clarification. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date. Verbal interpretation or explanation not issued in the form of an addendum shall not be considered part of the bidding documents. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.

B. The Architect/Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.5 CONTRACT DOCUMENT DISCREPANCIES

A. If any ambiguities should appear in the contract documents, the Contractor shall request clarification from the Architect/Engineer before proceeding with the work. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Architect/Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Architect/Engineer was requested and obtained before submission of bid.

B. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of three-dimensional objects. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies should be identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

C. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of materials or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.

D. If there is a conflict between manufacturer's recommendations and the Contract Documents, the manufacturer's recommendations shall govern with no additional cost to the Owner.

1.6 PERMITS

A. All permits, fees, licenses, etc. required for this project shall be obtained by the Contractor.

1.7 QUALITY ASSURANCE

A. Installers shall have at least 2 years of successful installation experience on projects with mechanical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation, unless noted otherwise in other mechanical sections.

B. Manufacturer of equipment and materials must be regularly engaged in the manufacture of the specified equipment and material with similar construction and capacities and whose products have been in satisfactory use in similar service for not less than five (5) years, unless noted otherwise in other Mechanical Sections.

C. Qualify welding processes and operators for structural steel according to AWS D1.1. "Structural Welding Code - Steel.

D. Quality welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Comply with provisions of ASME B31 Series "Code for Pressure Piping", including all addenda.

F. Contractor signed welder certificate(s) shall be submitted. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current. A record shall be maintained on the job site showing the date and results of qualification tests for each welder employed on the job. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner's representative.

G. For all the refrigerant work/service required by this project, all refrigerant technicians shall be EPA/ASHRAE 34 certified for corresponding classification type I, II, III and/or IV.

1.8 REFERENCES

A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following as applicable:

1. Safety and Health Regulations for Construction.

2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
3. ABMA - American Boiler Manufacturers Association.
4. ACCA - Air Conditioning Contractors of America.
5. ACGIH - American Conference of Governmental Industrial Hygienists.
6. ADC - Air Diffusion Council.
7. AGA - American Gas Association.
8. AIHA - American Industrial Hygiene Association.
9. AMCA - Air Movement and Control Association.
10. ANSI - American National Standards Institute.
11. ARI - Air-Conditioning and Refrigeration Institute.
12. ASA - Acoustical Society of American.
13. ASHRAE - American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
14. ASME - The American Society of Mechanical Engineers.
15. ASTM - American Society of Testing and Materials.
16. CAGI - Compressed Air and Gas Institute.
17. CTI - Cooling Tower Institute.
18. EJMA - Expansion Joint Manufacturers Association.
19. ETL - Engineering Tests Laboratory.
20. HEI - Heat Exchange Institute.
21. HI - Hydraulic Institute.
22. HYD I - Hydronics Institute.
23. ICBO - International Conference of Building Officials.
24. ICC – International Code Council.
25. NEBB - National Environmental Balancing Bureau.
26. NEC - National Electrical Code.
27. NEMA - National Electrical Manufacturers Association.
28. NFPA - National Fire Protection Association.
29. NSF - National Sanitation Foundation.
30. SAE - Society of Automatic Engineers.
31. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
32. TEMA - Tubular Exchanger Manufacturers Association.
33. UL - Underwriters Laboratories, Inc.
34. International Plumbing Code.
35. International Mechanical Code.
36. Other governing, state, and local codes that apply.

1.9 SUBMITTALS

A. General: Follow the procedures specified in Division 1 Sections "General Conditions" and “Special Conditions”.

B. Shop drawings shall include the minimum following information as applies. Additional specific information required is outlined in other Mechanical Sections.

1. Certified performance and data with system operating conditions indicated (winter and summer performance as necessary). All coil, fan, and pump performance data shall be computer generated.

    a. Submit sound power level data for all inlets, outlets, and casing radiation at rated capacities for all air handling equipment. Provide calculated sound power data based on AMCA 320 sound intensity test methods.
    b. Where filters are included with equipment, provide data of filter media, filter performance data, filter assembly, and filter frames.

2. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicating, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
3. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, gages and finishes of materials, and methods of assembly of components.
4. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to electrical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
5. Maintenance Data: Submit maintenance data and parts list for each mechanical equipment, control and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

C. Provide separate shop drawing submittals for all items listed in Shop Drawing and Submittal Log in Division 1.

D. Coordination drawings

1. Drawings:

a. Provide coordination in determining adequate clearance and space requirements for fire suppression equipment, mechanical equipment, electrical equipment, and other items/equipment in the project. The Architect/Engineer reserves the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades. The Architect/Engineer will only review conflicts and give an opinion but will not perform as a coordinator.

b. Provide coordination drawings indicating structural components, reflected ceiling layout, fire suppression items, mechanical items, electrical items, and other systems. Indicate on the coordination drawings where components will be installed and how the service access area to such items shall be maintained. Illustrate items requiring access for maintenance or adjustment.

c. The Contractor will not be allowed any time extensions for participation in the coordination drawing process. The Contractor will not be allowed any contract cost extra for any additional fittings, rerouting or changes of duct size to equivalent sizes to those shown on the drawings that may be determined necessary through the coordination drawing process.

d. Deviations from the contract documents that are necessary for overall system installation and coordination shall be brought to the attention of the Architect/Engineer. Such necessary changes in the contract scope discovered through the coordination drawing process will be covered by the requirements of the "change order" process.

e. Access panels shall occur only in gypsum wallboard or plaster ceilings where indicated on the drawings or as needed to provide access to equipment, dampers, or valves. Access to fire suppression and other items shall be through accessible acoustical ceiling areas. Additional access panels will not be allowed without written approval from the Architect/Engineer at the coordination drawing stage and only after alternatives are reviewed. Layout changes shall be made to avoid additional access panels. If additional access panels are required, they shall be provided at no additional cost to the Owner.

f. Soffit penetrations and light alcoves shall be fully coordinated with hanging devices, studs, fire/smoke ratings, and structural support requirements.

2. The Contractor and subcontractors responsible for items of work located in or above ceilings shall participate in the coordination drawing process. Participation is mandatory. If the Contractor or subcontractor fails to participate in the coordination drawing process, the Owner reserves the right to do the following:

a. Stop construction progress payments for work performed by the Contractor. Payments will be reinstated only after the Contractor or subcontractor resumes participation in the coordination drawing process.

b. Require the relocation and resizing of components as necessary to ensure components will be installed as intended. In the event the Contractor did not participate in the coordination process, the Contractor will not be entitled to contract cost increases or time extensions due to Owner-initiated changes in the work.

c. The Contractor shall be held responsible for unnecessary rework that is attributable to failure to participate in the coordination process.

3. Drawings shall be prepared at 1/4 inch = 1 foot, 0 inches (minimum).

a. Coordination participants shall provide equipment installation and clearance requirements. This information shall be indicated on the coordination drawings.

b. Coordination drawings shall indicate the following major system components (including insulation, hub or connection widths with verification of turning radius):

1) **Roof drain leaders**
2) **Large waste piping**
3) **Sprinkler mains**
4) **Equipment located above the ceiling**
5) **Heating hot water piping**
6) **Chilled water piping**
7) **Conduit runs 2 inches and larger**
8) **Cable tray**
9) **Bus duct**
10) **Recessed light fixtures**
11) **Building wiring or cable trays**
12) **Ceiling heights as shown in contract documents and thickness of system**
13) **Soffits (including framing of supports)**
14) **Access points and clearances required**
15) **Access panels**
16) **Valves**
17) **Dampers**
18) **Coils**
19) **Ductwork**
20) **Fire-rated wall, partition, and floor penetrations**
21) **Steam and condensate piping**
22) **Space allotted for future utilities**
23) **Equipment in mechanical and electrical spaces**

c. **Information shall be delineated to indicate distances from column centerlines, pipe/equipment size, and distance from finished floor to bottom of pipe/equipment and hangers.**

4. **The coordination drawings shall be submitted to the Architect/Engineer and Owner's representative for review. The submitted coordination drawings shall indicate which contractors participated in the process and where conflicts appear to occur even after the priority ranking of utility routing has been utilized. In the event that conflicts require input from the Architect/Engineer, recommended solutions will be provided with the coordination drawings for review by the Architect/Engineer. The Architect/Engineer will review and return an opinion to the contractors for implementation. All contractors shall agree to the final coordinated layout by signing off on the coordination drawings before any construction can begin.**
5. **Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Architect/Engineer and the Owner for review on a monthly basis with changes "clouded" and brought to the attention of the Architect/Engineer and the Owner.**

6. When a change order request is issued, the affected subcontractors shall review the coordination drawings and bring to the attention of the Contractor and the Architect/Engineer revisions necessary to the work of others not directly affected by the change order.

7. Contractors that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through accessible ceilings. Conflicts that result after the coordination drawings are signed off will be the responsibility of the Contractor or subcontractor who did not properly identify their work or installed the work improperly.

1.10 SUBSTITUTES

A. Refer to the General Conditions and Special Conditions sections of this Specification for general substitution requirements and information.

B. Where the terms "or equivalent" is used, the Contractor may substitute alternate equipment, materials, etc. subject to review by the Architect/Engineer and the Owner's representative during the submittal phase of the project.

C. Where the term "or approved equivalent" is used, the Contractor may not substitute alternate equipment, materials, etc. unless requesting approval at least ten (10) days before the bid date. Notifications of any such approvals by the Architect/Engineer shall only be made in writing by Addendum.

D. Where the term "no equivalent" is used, the Contractor must provide the specified or scheduled equipment, materials, etc.

E. Final determination regarding substitutions shall be by the Architect/Engineer.

1.11 WARRANTY

A. Refer to the General Conditions section of this Specification for general warranty requirements and information. Additional warranty requirements are specified in subsequent Mechanical Sections.

1.12 CLOSE OUT AND OPERATION INSTRUCTIONS

A. Operate each system and item of equipment in a test run of appropriate duration, but no less than 7 days, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.

B. Any system placed in temporary operation for testing or for the convenience of the Contractor during construction shall be properly maintained and operated by the Contractor.

C. All systems shall be protected against freezing, flooding, corrosion or other forms of damage prior to acceptance by the Owner.

D. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced to the satisfaction of the Owner's representative.

E. All tests shall be made after notification to and in the presence of the Owner's representative.

F. Before starting up any system, each piece of equipment comprising any part of the system shall be checked for proper lubrication and any other condition which may cause damage to the equipment or endanger personnel.

G. After systems have been demonstrated to be satisfactory for 7 consecutive days and ready for permanent operation, all permanent pipe line strainers shall be cleaned, valve and packings properly adjusted, lubrication checked and replenished if required. Temporary piping, etc. shall be removed and openings restored in a permanent manner acceptable to the Owner's representative.

H. Conduct a walk-through instruction seminar for the Owner's personnel pertaining to the continued operation and maintenance of mechanical equipment and systems. Explain the identification system, maintenance requirements, operational diagrams, temperature control provisions, sequencing requirements, security, safety, efficiency and similar features of the systems. Walk through must be documented as to those attending and subjects covered. Walk through document(s) shall be signed and dated by the contractor's representative and the owner's representative.

1. Provide instructional training as outlined in individual equipment specification sections.

I. At the time of substantial project completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.

1. If any systems are operated prior to substantial completion, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

1.13 RECORD DOCUMENTS

A. Prepare as-built documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in above, indicate the following installed conditions:

1. The Mechanical Contractor shall provide the Owner with as-built drawings for ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units and indicate all devices requiring periodic maintenance or repair, such as control power transformers, LACS panels/routers, field controllers, duct static pressure sensors, piping pressure sensors, etc.
2. All mechanical systems as described in the Specifications and/or shown on the drawings.
3. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section "Mechanical Identification." Indicate actual inverts and horizontal locations of underground piping.
4. Equipment/material locations (exposed and concealed), dimensioned from prominent building lines.
5. All items must be dimensioned in horizontal and vertical plans to allow Architect/Engineer to update Building Information Model (BIM) file for Owner.

1.14 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

B. Provide electronic copies, preferably in Adobe Acrobat Portable Document Format (pdf), of all maintenance manuals to Temperature Control Contractor for use in EMCS front-end system. Provide data in file types compatible with EMCS.

2. PRODUCTS (NOT APPLICABLE).

3. EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Store and handle material and equipment in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

C. Use proper lifting equipment where size/weight requires handling by such means.

D. Comply with manufacturer's rigging and moving instructions for unloading material and equipment, and moving them to final location.

E. Equipment requiring disassembly for access purposes shall be disassembled and reassembled as required for movement into the final location following manufacturer's written instructions.

F. Deliver material and equipment as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

G. Mechanical Contractor shall schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site.

3.2 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.3 COORDINATION

A. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

B. Coordinate the mechanical work with work of the different trades so that:

1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
2. Within the limits indicated on the drawings, the maximum practicable space for operation, maintenance repair, removal and testing of mechanical and other equipment will be provided.
3. Pipes, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.

C. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.

D. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

3.4 MECHANICAL INSTALLATIONS

A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.

B. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.

C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Architect/Engineer and the Owner's representative shall be notified and any changes approved before proceeding with the work.

D. Arrange for chases, slots, and openings in other building components during progress of construction to allow for mechanical installations.

E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom.

F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

G. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

I. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

K. Welding, sweating, or brazing operations

1. All cutting, welding, brazing, or sweating operations carried on in the vicinity of, or accessible to, combustible material shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.
2. When it is necessary to do cutting, welding, brazing, or sweating close to wood construction, in pipe shafts, or other locations where combustible materials can not be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. Position another individual nearby to guard against sparks and fire.
3. Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations, or spatter from electric arc operations, a guard shall be kept at the place of work for at least one hour after completion to verify that smoldering fires have not been started.
4. Whenever welding or cutting operations are carried on in a vertical shaft or where floor openings exist, a fire guard shall be employed to examine all floors below the point of the welding or cutting operation. The fire guard shall be kept on duty for at least one hour after completion to verify that smoldering fires have not been started.
5. Before any work involving cutting, welding, brazing, or sweating operations is started, consult with the Architect/Engineer as to particular safety precautions to be employed on the work.

3.5 ACCESSIBILITY

A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.6 LUBRICATION AND TOOLS

A. Provide a fresh charge of lubricant in accordance with manufacturer's recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by Owner.

B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's representative prior to final acceptance of the equipment.

3.7 START-UP

3.8 PIPING SYSTEMS PRESSURE TESTING

A. The following personnel in the order listed shall be considered acceptable witnesses of all piping pressure testing:

1. Local Authority Having Jurisdiction
2. Owner's Representative
3. Mechanical Engineer / Architect
4. General Contractor's Foreman

B. Removal of pressure charge and associated drain down shall also be witnessed.

C. Mechanical contractor shall provide a minimum of 24-hour notice to at least one of the above listed parties before commencing any piping systems pressure test.

D. Pressure gauge requirements: Provide recently calibrated gauge with 4" face and a range such that test pressure is between 50% and 100% of gauge range. For example, a gauge with a 15 psig range is acceptable for a 10 psig pressure test, whereas a gauge with a 30 psig range is unacceptable in this application. Gauge resolution shall be suitable for type of testing, system size and test media. Gauge shall have been recently calibrated.

E. All piping pressurizing equipment (i.e., air compressor) shall be disconnected before test is commenced and shall remain disconnected for the entire duration of the test.

F. Entire system shall be properly vented before test is commenced.

G. For specific piping pressure testing requirements and procedures, see applicable piping systems specification sections.

H. Submit completed "Pipe Pressure Test Log" provided at the end of this Section for each pressure test before final project closeout. Test log shall also be included in operation and maintenance manuals.

NOTE: USE MULTIPLE FORMS IF NECESSARY

3.9 GENERAL CONTRACTOR - MECHANICAL EXTENT OF WORK

A. Access Panels

1. Furnish and install panels for access to valves and dampers and similar items where no other means of access, such as readily removable, sectional ceiling is shown or specified.

2. The plans indicate the location of all anticipated access panels. The Division 23 Contractor shall make every effort to locate all material and equipment requiring service and maintenance above accessible ceilings or utilize the indicated access panels. Material and equipment requiring service and maintenance that is shown above inaccessible ceilings shall be relocated to accessible or exposed areas whenever possible. When these items are located in exposed areas, the Division 23 Contractor is to verify with the Architect/Engineer that the installation will not affect the aesthetics of the building. However, when it is not possible to locate these items in accessible or exposed areas due to the configuration of the actual installation of the mechanical and other trade systems or aesthetic reasons, additional access panels shall be provided. The contractor shall be equitably compensated for the additional access panels.
3. Refer to Section 08 31 13 – Access Doors and Panels for specific information on type and size of panels

B. Cutting and Patching

1. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

2. The Division 23 Contractor shall coordinate all cutting and patching of holes, in existing building and new construction which are required for the passage of mechanical work.
3. Division 23 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all cutting and patching requirements. The Division 23 Contractor shall be liable for all associated costs of cutting and patching for mechanical work upon failure to notify the General Contractor prior to bid submission.
4. Under no circumstances shall any structural members, load-bearing walls or footings be cut without first obtaining written permission from the Engineer.
5. Cut, channel, chase and core drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
6. Patching of concrete openings shall be filled with grout and finished smooth with the adjacent surface.
7. All below-grade openings for pipe shall be sealed with interlocking synthetic rubber line assembly, Link-Seal by Thunderline Corporation or equal.
8. **All penetrations through the walls, floor, or structure of laboratory spaces, laboratory support spaces, lecture halls, classrooms, conference rooms, corridors or other areas in which relative pressurization relationships are important shall be sealed airtight. Refer to the drawings for additional information regarding rooms in which maintaining pressurization is important.**
9. Repair cut surfaces to match adjacent surfaces.
10. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

    a. Uncover work to provide for installation of ill-timed work.
    b. Remove and replace defective work.

c. Remove and replace work not conforming to requirements of the Contract Documents.
d. Remove samples of installed Work as specified for testing.
e. Install equipment and materials in existing structures.
f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Concrete Bases

1. Provide 4" high concrete housekeeping pads (unless otherwise noted) shall be provided under floor mounted mechanical equipment. Thicker pads are not allowed unless approved by engineer. Concrete inertia pads shall be provided for all base-mounted pumps and air compressors installed in the penthouse area.
2. Division 23 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all mechanical equipment bases. The Division 23 Contractor shall be liable for all associated costs to install the mechanical equipment bases upon failure to notify the General Contractor prior to bid submission.
3. Construct concrete equipment bases a minimum 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive strength concrete, reinforcement and forms as specified in Division 3 Section "Cast-In-Place Concrete." Coordinate final equipment base size with General Contractor.

D. Roof curbs, roof support for mechanical equipment and roof penetrations.

1. Division 23 Contractor is to coordinate with the General Contractor all roof curb and roof supports supplied, number, size and location of all roof penetrations. All major roof penetrations are shown on the architectural roof plan. General Contractor shall be notified of all additional roof penetrations provided by the Division 23 Contractor not shown on this plan. The General Contractor shall provide all roof deck mounted equipment and pipe supports, pipe penetrations and cut roof deck for pipe and duct penetrations, unless noted otherwise. The Division 23 Contractor shall furnish all roof curbs and the General Contractor shall install, unless noted otherwise. The Division 23 Contractor shall provide all roof covering/membrane mounted equipment and pipe supports and roof drains, unless noted otherwise.
2. The Division 23 Contractor shall be liable for all associated costs to install the roof curbs, roof supports and roof penetrations not shown on the roof plan or added after the roof system has been installed. Coordinate with the General Contractor prior to construction the number size and location of all roof penetrations.
3. Division 23 Contractor is to coordinate with the General Contractor all roof curb and roof supports supplied, number, size and location of all roof penetrations. All major roof penetrations are shown on the architectural roof plan. General Contractor shall be notified of all additional roof penetrations provided by the Division 23 Contractor not shown on this plan.

E. Painting

1. The General Contractor is to field paint mechanical equipment and materials in specified areas as noted on the mechanical plans, mechanical schedules and in the specifications. Division 23 Contractor is to coordinate the painting of these items with the General Contractor. The Mechanical Contractor is to provide materials in these areas that are suitable for accepting paint. The clean and preparation of the materials to reach paint is the responsibility of the General Contractor unless noted specifically to be responsibility of the Division 23 Contractor.
2. In concealed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted with one coat of zinc rich paint.
3. In exposed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted in accordance with Section 09 91 00.

3.10 ELECTRICAL-MECHANICAL EXTENT OF WORK

A. The responsibility of work specified under Division 23 and 26 is clarified under, Section 23 05 13, "Electrical Requirements for Mechanical Equipment. Division 23 Contractor is to coordinate all electrical requirements prior to ordering powered mechanical equipment.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 05 13
ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

1. GENERAL

1.1 SECTION INCLUDES

A. Electrical Requirements for:

1. Motors
2. Starters, Electrical Devices, and Wiring
3. Manual Motor Starters
4. Motor Connections
5. Capacitors
6. Safety Switches

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Electrical components and materials shall be UL labeled and listed.

B. References.

1. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:

a. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
b. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
c. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
d. ANSI/NEMA Standard MG 1 – Motors and Generators.
e. ANSI/NFPA 70 - National Electrical Code.
f. NEMA Standard ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
g. NEMA Standard 250 – Enclosures for Electrical Equipment.
h. NEMA Standard KS 1 – Enclosed Switches.

C. Submittals.

1. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, or as required by the individual equipment specification sections.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and holding

G. Related sections.

1. Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.3 SUMMARY

A. This section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment. In addition, this section covers necessary coordination issues between mechanical and electrical disciplines. All mechanical and electrical construction documents must be completely reviewed by the Mechanical and Electrical Contractors prior to the submission of bids. Any discrepancies in the documents should be brought to the Architect/Engineer's attention at that time. Failure to properly coordinate or review documents in advance of submission of bids will not be valid cause for changes to the overall Contract amount.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

2. PRODUCTS

2.1 MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Minimum service factors shall be as follows:

Motor Service Factor Schedule		
Horsepower:	**3600 RPM:**	**1800 RPM:**
1/6 – 1/3	1.35	1.35
1/2	1.25	1.25
3/4	1.25	1.25
1 – 1.25	1.25	1.15

1.5 - 150	1.15	1.15

3. Two-speed poly-phase motors shall have two separate windings served by a single point electrical connection to the two speed starter. Two speed starters shall be located at the motor location unless otherwise noted.
4. Temperature Rating: Rated for 40 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
5. Starting capability: Frequency of starts as indicated by automatic control system, and not less than five (5) evenly timed starts per hour for manually controlled motors.
6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.

    a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit each specific application.
    b. Bearings: Ball or roller bearings with inner and outer shaft seals; re-greasable; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.
    c. Enclosure Type: Unless otherwise noted, use open drip-proof motors where satisfactorily housed or remotely located during operation; guarded drip-proof motors where exposed to contact by employees or building occupants; weather protected Type I for outdoor use, Type II where not housed.

    d. Overload protection: Built-in thermal overload protection (in accordance with NEC requirements) and, where indicated, an internal sensing device suitable for signaling and stopping the motor at the starter.

7. Noise rating: "Quiet"
8. Efficiency: **"Premium efficiency"** motors, as defined in NEMA MG 1, most recent edition.
9. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
10. All three-phase motors shall be inverter duty type.
11. Motors Used With Variable Frequency Drives: Ratings, characteristics, and features coordinated with and approved by drive manufacturer. Motor shall be designed and labeled for use with variable frequency drives. Motor shall be designed with critical vibration frequencies outside the operating range of the drive output and shall be suitable for use throughout speed range without overheating.

    a. Provide AEGIS SGR, or approved equivalent, shaft grounding ring/system to divert adverse shaft currents away from the motor bearings. Use AEGIS Colloidal Silver Shaft Coating (PN CS015), or approved equivalent, prior to ring installation. Install coating and ring per manufacturer recommendations.

2.2 SHEAVES

A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.

B. When replacing sheaves, use sheaves of at least the originally supplied sizes.

C. Contractor shall be responsible for replacement sheaves required to achieve specified performance. Coordinate with testing and balancing of the equipment.

2.3 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor-Starter Characteristics: Motor starters shall be compatible with the equipment they serve. In general, motor starter characteristics shall meet the requirements of Division 26 specification sections and as outlined as follows:

B. Unless specifically approved in writing by the engineer, or as stated later in this paragraph, motor starters, VFDs and motor controllers (including equipment with integral motor starting) for motors shall have short circuit current ratings equivalent to the switchboard or electrical panel serving the load immediately upstream of the load. Refer to the electrical drawings for switchboard and electrical panel ratings. Provide additional overcurrent device protection if necessary to meet this requirement.

1. Exception: Where a motor or combination of motors is less than 10 horsepower in total and fed by more than 50 feet of wiring between the switchboard or panel that it is served by and the motor starter/controller/VFD, the starter/controller/VFD may have a short circuit current rating of 5000 Amps.

C. Motor Connections

1. Provide connections to motors in accordance with the requirements listed in the electrical specifications.
2. See Division 26 for the use of lugs for motor connections.

D. Capacitors

1. Capacitor features shall include:

a. Individual unit cells.
b. All welded steel housing.
c. Each capacitor shall be internally fused.
d. Non-flammable synthetic liquid impregnate.
e. Craft tissue insulation.
f. Aluminum foil electrodes

2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

E. FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

F. FULL VOLTAGE NON-REVERSING COMBINATION STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

G. MANUAL MOTOR STARTERS

H. See specification section 26 29 13 – Motor Controllers for requirements.

I. CAPACITORS

1. Capacitor features shall include:

a. Individual unit cells.
b. All welded steel housing.
c. Each capacitor shall be internally fused.
d. Non-flammable synthetic liquid impregnate.
e. Craft tissue insulation.
f. Aluminum foil electrodes

2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

2.4 SAFETY SWITCHES

A. See specification section 26 05 01 – Basic Electrical Materials and Methods.

3. EXECUTION

3.1 INSTALLATION

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

END OF SECTION

SECTION 23 05 19
HVAC METERS AND GAGES

1. GENERAL

1.1 SECTION INCLUDES

A. Sight flow indicators.

B. Pressure gages and pressure gage taps.

C. Thermometers and thermometer wells.

D. Piping pressure and temperature test plugs.

E. Static pressure and filter gages.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References

C. Submittals

D. Operation and maintenance manuals.

E. Project record documents

1. Accurately record actual locations of instrumentation.

F. Delivery, storage, and handling

1.3 ENVIRONMENTAL REQUIREMENTS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

2. PRODUCTS

2.1 SIGHT FLOW INDICATORS

A. Bronze or stainless-steel body, with sight glass and paddle wheel indicator, threaded or flanged ends.

B. Minimum pressure rating: 150 psig.

C. Minimum temperature rating: 200 deg F.

D. End connections for NPS 2 inch and smaller: Threaded.

E. End Connections for NPS 2-1/2 inch and larger: Flanged.

2.2 PRESSURE GAGES

A. Standard: ASME B40.200.

B. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection, liquid-filled.

C. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.

D. Connector: Brass, 1/4-inch NPS.

E. Scale: White coated aluminum, with permanently etched markings.

F. Accuracy: Plus or minus 1 percent of range span.

G. Range: Conform to the following:

1. Vacuum: 30 inches Hg to 15 psi.
2. All fluids: 2 times operating pressure.

2.3 PRESSURE GAGE ACCESSORIES

A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.4 GLASS THERMOMETERS

A. Standard: ASME B40.200.

B. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.

C. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Tube: Red reading, magnifying lens, with non-mercury fluid.

E. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.

F. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

G. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

H. Scale range: Temperature ranges for services listed as follows:

1. Condenser/Heat Pump Water: 0 to 160 deg F with 2-degree scale divisions (minus 18 to 70 deg C with 1-degree scale divisions).
2. Heating Water: 30 to 250 deg with 2-degree scale divisions (0 to 150 deg C with 1-degree scale divisions).
3. Chilled Water: 0 to 100 deg F with 2-degree scale divisions (minus 20 to 50 deg C with 1-degree scale divisions).
4. Steam and Condensate: 50 to 400 deg F with 2-degree scale divisions (0 to 200 deg C with 1-degree scale divisions).

2.5 THERMOMETER WELLS

A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.6 PIPING PRESSURE AND TEMPERATURE TEST PLUGS

A. Test Plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:

1. Air, Water, Oil, and Gas, 20 to 200 deg F (minus 7 to 93 deg C): Neoprene.

2.7 STATIC PRESSURE GAGES

A. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.

B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch (6 mm) diameter tubing.

C. Construction: Bronze or stainless-steel body, with sight glass and [ball, flapper, or paddle wheel] <Insert device> indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: [125 psig (860 kPa)] [150 psig (1034 kPa)] <Insert value>.

E. Minimum Temperature Rating: [200 deg F (93 deg C)] <Insert temperature>.

F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

3. EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 FLOW MEASURING METERS

A. Install where shown on plans and schematics as indicated.

B. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions and as detailed on drawings.

C. Install flowmeter elements in accessible positions in piping systems. Maintain manufacturer-recommended minimum upstream and downstream distances.

D. Install permanent indicators on walls or brackets in accessible and readable positions.

E. Install connection fittings in accessible locations for attachment to portable indicators.

F. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

G. Install flow meters for piping systems located in accessible locations at most readable position.

H. Calibrate meter after installation in accordance with manufacturer's installation instructions.

I. Connect meters to EMCS. Coordinate with controls contractor and provide all necessary interconnections for accurate transmission of data.

J. Installation of steam meter and associated wiring, pressure transmitter and RTD assembly, shall be in strict accordance with manufacturer's printed instructions and recommendations, applicable BOCA requirements, and as detailed on drawings.

K. Swirl meters shall be installed in a horizontal position with a minimum of five straight pipe diameters upstream and three straight pipe diameters downstream. Meter head shall be installed in the horizontal plane or facing down as detailed in instructions for high temperature applications.

L. Swirl meter shall be installed prior to all steam pressure reducing valves and modulating control valves.

M. Pressure and temperature taps shall be installed a minimum of three pipe diameters downstream, before any isolation valves.

N. Swirl meter transmitter shall be located in an accessible location to permit ease of reading and service of transmitter.

O. Low-voltage wiring to the steam meter and flow computer shall be made in coordination with Energy Management Steam and Water Distribution personnel.

P. The final wiring connections to the swirl meter, pressure transmitter and RTD will be made by Energy Management Steam and Water Distribution personnel.

Q. Steam will not be turned on by Energy Management Steam and Water Distribution personnel until the steam meter is fully installed and operating satisfactorily and the downstream steam piping is successfully leak tested and secure.

R. Only Energy Management Steam and Water Distribution personnel will be authorized to turn steam service on or off.

3.3 PRESSURE GAGES

A. Install pressure gages in piping tee with pressure gage valve, located on pipe at most readable position.

B. Install as shown on plans, and elsewhere as indicated.

C. Pressure Gage Ball Valves: Install in piping tee with snubber. Install syphon in lieu of snubber for steam pressure gages.

3.4 THERMOMETERS

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Install as shown on plans and elsewhere as indicated.

C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.5 TEST PLUGS

A. Test Plugs: Install where indicated, located on pipe at most readable position. Secure cap.

3.6 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 23 05 29
HVAC HANGERS AND SUPPORTS

1. GENERAL

1.1 SECTION INCLUDES

A. Pipe, ductwork, and equipment hangers, supports, anchors, saddles and shields.

B. Mechanical flashing.

C. Equipment curbs.

D. Mechanical sleeves and seals.

E. Flashing and sealing equipment and pipe stacks.

F. Sealants, firestop insulation, putty and compounds.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and handling.

2. PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Hydronic Piping:

1. Conform to International Mechanical Code, ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89 as applicable.

B. Steam and Steam Condensate Piping:

1. Conform to International Mechanical Code, ASME B31.9, ASTM F708, MSS SP58, MSS SP69, MSS SP89, as applicable.

C. Hangers and Supports:

1. Hangers for Hot and Cold Pipe Sizes 1/2 to 1-1/2 Inch, Carbon steel, adjustable swivel, band type.
2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 to 4 Inches; Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
7. Wall Support for Hot Pipe Sizes 6 Inches (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
10. Vertical Support: Steel riser clamp.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
14. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
15. Roof Support for Hot and Cold Pipe: See PIPE STANDS section below.
16. **Hangers for insulated pipe shall be enlarged to compensate for insulation thickness so that hangers support insulation. See Section 23 07 19.**
17. See Section 23 05 48 for vibration isolation hangers and supports if applicable.

2.2 DUCTWORK HANGERS AND SUPPORTS

A. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

B. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

C. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Exposed Stainless-Steel Ducts: Stainless-steel shapes and plates.

2.3 ACCESSORIES

A. Hanger Rods: ASTM A36 steel or galvanized threaded both ends, threaded one end, or continuous threaded.

1. Ductwork: Use double nuts and lock washers on threaded rod supports.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Internally Threaded Screw Anchors: Internally threaded, self tapping screw anchors, Power Fasteners Snake or approved equivalent.

1. Tested in accordance with ACI 355.2 and ICC-ES AC193 for use in structural concrete under the design provisions of ACI318 (Strength Design method using Appendix D)

2.5 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.6 FLASHING

A. Metal Flashing: 26 gage galvanized steel.

B. Metal Counterflashing: 22 gage galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb/sq ft sheet lead
2. Soundproofing: 1 lb/sq ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet buty; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.7 EQUIPMENT CURBS

A. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, 1-1/2 inch thick insulation, factory installed wood nailer. Minimum 18 inch height, unless specified otherwise.

2.8 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage galvanized steel.

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel.

2.9 SEALANTS, FIRESTOP INSULATION, PUTTY, AND COMPOUNDS

A. Firestopping Insulation: Glass fiber type, non-combustible, UL listed.

B. Firestop Putty: Non-harding, non shrinking, UL listed.

C. Firestop Compounds: Cementitous material, non-shrinking, UL listed.

D. Sealants:

1. Non fire/smoke rated partitions: Acrylic or silicone based caulking.
2. Fire/smoke rated partitions: Silicone based caulking, UL listed.

2.10 MECHANICAL SEALS

A. Mechanical Seals: Modular mechanical type, consisting of interlocking EPDM synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with type 316 stainless steel bolts and reinforced plastic polymer pressure plates which cause rubber sealing elements to expand when tightened, providing a watertight and gas-tight seal and electrical insulation. Provide Link-Seal or equivalent.

1. Provide high-temperature silicone links rated for 400 Deg. F for steam and condensate applications.

2. A sleeve shall be provided for each mechanical seal.

a. Thermoplastic sleeves: Sleeve shall have smooth walls and shall be made of molded non-metallic high density polyethylene (HDPE) with an integral solid water stop, Advance Products & Systems Model PWS or equivalent.
b. Steel sleeves: Sleeve shall have smooth walls, shall be made of Schedule 40 steel with an integral welded solid water stop, and shall have corrosion-resistant coating, Advance Products & Systems Model GWS or equivalent.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Support fire protection systems piping independently from other piping systems. Fire main piping may be trapezed with other piping systems. Coordinate trapeze hangers with the Sprinkler Contractor.

1. Reference sections 21 05 29 and 22 05 29 for additional information regarding fire protection and plumbing piping supports and hangers.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for non-insulated copper pipe.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat steel hangers and supports in the mechanical room and other exposed areas. Refer to the Architectural reflected ceiling plans for location of exposed ceilings. Hangers and supports located in attic space, crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Adjust hangers to distribute loads equally on attachments and to achieve specified pipe slopes.

N. Saddles, Shields and Inserts

1. Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
2. Install protective shields MSS Type 40 on cold piping that has vapor barrier. Shields shall span an arc of 180 degrees (360 degrees on trapeze hangers with U-bolt clamps) and shall have dimensions in inches not less than the following:

NPS	LENGTH	THICKNESS
1 through 3-1/2	12	0.048
4	12	0.060
5 & 6	18	0.060
8 through 14	24	0.075
16 through 24	24	0.105

3. Insert materials shall be at least as long as the protective shield.
4. Provide manufacturer-recommended saddles, inserts, and/or shields where cellular foam insulation is used. The removal of sections of cellular foam insulation for the purpose of pipe support is not acceptable.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls and floors.

B. Flash drains in floors with topping over finished area with lead, inches clear on sides with minimum 36 x 36 inch sheet size. Fasten to drain clamp device.

C. Seal floor, shower, mop sink, etc. drains watertight to adjacent materials.

D. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 SLEEVES

A. Provide pipe and duct sleeves at all fire/smoke rated partitions, exterior wall penetrations and wall penetrations into exposed areas. Pipe and duct sleeves are not required for penetrations through non-rated concealed partitions.

B. At the Contractor’s option, pipe sleeves may be omitted if the wall or floor is core drilled.

C. Set sleeves in position in formwork. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Sleeves through floors shall be grinded flush with finish floor level.

F. Where piping or ductwork penetrate non-rated ceilings or walls, close off space between pipe or duct and adjacent work with urethane rod stock and caulk air tight.

G. Seal pipe and duct penetrations through non-rated floors.

1. Where piping is not located in a rated shaft and it penetrates a single non-rated floor, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.
2. Where piping is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between pipe and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.
3. Where ductwork is not located in a rated shaft and it penetrates a single non-rated floor, close off space between duct and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.
4. Where ductwork is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between duct and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound. Install fire damper in duct at each floor level. Ductwork containing fume exhaust air shall not be provided with fire dampers.

H. Where piping or ductwork penetrate rated floor, ceiling, or wall, close off space between pipe or duct with appropriate fire rated sealant, insulation, putty or compound. Refer to the Drawings for fire/smoke rated wall locations and the appropriate ratings.

I. Provide on ductwork close fitting metal collar or escutcheon covers on the side of penetration that are exposed to view.

J. Install chrome plated steel escutcheons on piping at finished surfaces.

K. Provide mechanical seals and sleeves through exterior wall and floor penetrations and 3 hour or higher fire rated partitions.

3.8 HANGER SCHEDULES

A. Reference International Plumbing Code and International Mechanical Code where applicable.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 05 48
HVAC VIBRATION CONTROLS

1. GENERAL

1.1 Coordinate requirements of this specification with all other specifications and trades. Requirements of this specification take precedence over other specification sections. For example, the requirements of this section with regard to pipe supports in mechanical rooms take precedence above the requirements of Section 23 05 29.

1.2 This specification pertains to the furnishing and installation of vibration isolation devices for rotating or reciprocating mechanical equipment and piping and conduit systems attached thereto, and electrical transformers and attached switchgear and conduit systems.

1.3 This work shall include all material and labor required for installation of the resilient mounting and suspension systems, adjusting each mounting system, and measurement of isolator system performance when so requested by the Architect. Specific mounting arrangements for each item of mechanical and electrical equipment shall be as described herein and as indicated by schedules and details on the drawings.

1.4 All vibration isolation equipment except for resilient pipe connectors, including steel framing and reinforcing for concrete inertia bases and including steel rail bases, shall be furnished by Mason Industries or Kinetics Noise Control. A single manufacturer for all vibration isolation equipment in Sections 22 05 48, 23 05 48, and 26 05 48 will be required except as specifically approved in writing by the Architect or by his specific approval of shop drawings or as specified herein. For resilient pipe connectors refer to provisions of this specification that follow.

1.5 SECTION INCLUDES

A. Vibration isolation systems.

1.6 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING GUIDELINES

A. References

B. Submittals

C. Delivery, storage and handling

1.7 ADDITIONAL REQUIREMENTS

A. The Contractor and the vibration isolation manufacturer or his regularly designated and factory authorized representative shall perform the following tasks in addition to the supply and installation of isolation equipment:

1. Obtain from the Architect the approved manufacturer's name, model number, and other necessary identifying data for each item of mechanical and electrical equipment to be resiliently mounted. Coordinate all resilient mounting systems with the exact equipment to be furnished in regard to physical size, isolator locations, weight, rotating speed, etc. Direct contact and cooperation between the vibration isolation device fabricator and the equipment manufacturer will be required.
2. Obtain all necessary data in regard to piping systems which are to be resiliency supported so that proper isolators can be selected. Select piping system isolators for proper coordination with the physical arrangement of pipe lines and with the physical characteristics of the building.
3. Submit shop drawings as required by other portions of this specification. These drawings shall include specification information as follows:

    a. Manufacturer's model number for each isolator, the machine or pipeline to which it is to be applied, and the number of isolators to be furnished for each machine or pipeline.
    b. For steel spring mounts or hangers - Free height, deflected height, solid height, isolator loading, and diameter of spring coil.
    c. For elastomer or glass fiber isolators - Free height, deflected height, and isolator loading.
    d. Dimensional and weight data for concrete inertia bases, steel and rail bases, and details of isolator attachment.

4. Provide on-the-job supervision as required during installation of resiliently mounted equipment and piping to assure that all vibration isolators are installed in strict accordance with normally accepted practices for critical environments.
5. Replace at no extra cost to the Owner any isolators which do not produce the required deflection, are improperly loaded above or below their correct operating height, or which in any way do not produce the required isolation.
6. Cooperate with all other Contractors engaged in this project so that the installation of vibration isolation devices will proceed in a manner that is in the best interests of the Owner.
7. Notify the Architect of any project conditions which affect vibration isolation system installation or performance and which are found to be different from conditions indicated by the drawings or described by the specifications. Should vibration isolation system installation proceed without such notifications any remedial work required to achieve proper isolator performance shall be accomplished by the Contractor at no additional cost to the Owner.

8. Be alert for possible "short-circuiting" of vibration isolation systems by piping supports, electrical connections, temperature control connections, drain lines, building construction, etc., and notify the involved contractor as to these problems or potential problems. Where such situations cannot be easily resolved, notify the Architect so that preventive or remedial action can take place on a timely basis. Any remedial measures required shall be undertaken by the contractor responsible at no additional cost to the Owner.
9. This specification does not include provisions for seismic restraints that might be required by isolations systems due to the geographic location of the project, building codes, or other considerations.

2. PRODUCTS

2.1 VIBRATION ISOLATION SYSTEMS:

1. General:

   a. The vibration isolation systems described herein and identified by type letter designations shall be applied to specific classifications of mechanical and electrical equipment as indicated by Section C of this document.
   b. The minimum static deflection of the isolators for each classification of mechanical or electrical equipment shall be as indicated by Section C of this document or as otherwise indicated herein.

2. Type A Isolation:

   a. The equipment shall be rigidly mounted on a large reinforced concrete inertia base which has length and width dimensions approximately 20% greater than the supported equipment. The inertia base and equipment shall be supported by steel spring vibration isolators. Brackets for the spring isolators shall be located off the sides of the inertia base or integral with the perimeter of the inertia base with the tops of the springs near the vertical center of gravity of the equipment and inertia block; or if the center of gravity is higher than the top of the inertia base, the tops of the springs shall be at the top of the inertia base. The spring isolators shall rest on curbs or pedestals if necessary. There shall be a 2 inch minimum space between the bottom of the inertia base and the top of the housekeeping pad or floor slab when a housekeeping pad is not indicated to be employed.
   b. Concrete inertia bases shall be formed by a welded steel channel frame which incorporates prelocated equipment anchor bolts, and reinforcing bars in each direction welded in place. Concrete shall be standard 150-160 Ib/cu.ft. structural concrete. The base thickness shall be determined by the weight requirements but it shall be a minimum of 8% of the longest span between isolators or 6 inches, whichever is greater. For centrifugal and axial fans and centrifugal pumps the inertia base shall have a minimum weight equal to that of the isolated equipment. For reciprocating equipment the inertia base shall have a minimum weight equal to twice the weight of the equipment.

c. Springs shall be of the free standing unhoused type. Horizontal spring stiffness shall not be less than 0.8 of vertical stiffness. Springs shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection of each spring shall not be less than that specified for each classification of mechanical equipment. The spring deflection from the point of rated deflection to the point at which the spring is solid shall not be less than 1/2 of the rated static deflection. The yield point of the steel used in the springs shall be sufficiently great so that the springs may be compressed to shorted turns without danger of spring failure. At least two layers of ribbed waffle pattern neoprene pads or equivalent glass fiber pads shall be installed under the base plate of each spring isolator. Springs shall have leveling bolts and proper means for bolting to the machines. To prevent corrosion, springs for outdoor installation shall be galvanized or otherwise coated as approved by the Architect.

3. Type B Isolation:

a. The equipment shall be rigidly mounted on wide flange or channel structural steel members which shall run perpendicular to any support channels or similar members which are an integral portion of the equipment, or which shall be fabricated to form a complete frame for machine mounting. Height saving spring mounting brackets shall be welded to the ends of the structural steel saddle members or to the sides of structural steel frames to attach free standing steel spring isolators. Unless otherwise approved, the depth of the structural steel saddle members or the perimeter members of mounting frames shall be at least one-tenth of the longest frame dimension.
b. Steel spring isolators shall be as specified for Type A isolation.
c. Minimum clearance between the steel base and the housekeeping pad or floor shall be 2 inches.

4. Type C Isolation:

a. The equipment shall be rigidly mounted in a steel frame which is sufficiently stiff so that it may be supported on resilient isolators without distortion of the frame or misalignment of the equipment. If the equipment has an integral frame which is suitably rigid, the resilient isolators may be secured directly to the integral equipment frame or base.
b. Isolators shall be selected on the basis of the required static deflection as scheduled or otherwise indicated, and as follows:

1) Required deflection 0.25 to 0.4 inches - double deflection neoprene-in-shear isolators.
2) Required deflection 0.5 inches and greater - steel spring isolators as specified for the Type A mounting.

c. Isolators shall be selected for reasonably uniform deflection taking into consideration any difference in machine weight at each supporting point, but deflection shall not be less than that specified for each classification of equipment.
d. Minimum clearance between the equipment base and the house keeping pad or floor shall be 2 inches.

5. Type D Isolation:

a. The equipment shall be mounted on resilient "pads". These pads shall be multiple layers of waffle or ribbed neoprene, neoprene and cork sandwich, or precompressed glass fiber with height and stiffness as required to provide the static deflection as scheduled or specified and as required to properly support the load.
b. Pads shall be loaded in accordance with the manufacturer's recommendations and sized to achieve this recommended loading. The equipment weight at each sup porting point shall be considered in selecting pad dimensions along with the recommended loading.

3. EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

C. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.5 RESILIENT MOUNTINGS FOR SPECIFIC CLASSIFICATIONS OF MECHANICAL EQUIPMENT:

EQUIPMENT	LOCATION	ESTIMATED MINIMUM ROTATING SPEED (RPM)	ISOLATION TYPE	MINIMUM ACTUAL STATIC DEFLECTION (INCHES)

Base Mounted Pumps	First Floor Mechanical Room	1800	C	3.0

3.6 ISOLATION OF PIPING SYSTEMS:

A. All piping and rigidly connected devices such as pressure reducing valves which connects to resiliently mounted equipment shall be suspended with resilient hangers or supported by floor mounted isolators for a distance of 100 pipe diameters from the connected machine or within the mechanical equipment room, whichever is the greater distance. The first three supports from the connected machine shall have the same static deflection as indicated for the machine; the next two supports shall have static deflection at least equal to one-half of the static deflection indicated for the machine mounting, and remaining pipe supports shall provide static deflection of 0.35 inches minimum. These remaining isolators may be elastomer.

B. Vertical pipe risers shall be resiliently mounted, preferably with each riser anchored near the center of the run. The risers shall be supported at the anchor points with steel spring or double deflection neoprene-in-shear isolators which provide static deflection of at least 0.35 inches. Isolators for the remainder of each run shall be steel spring type specifically designed to control load shifting due to pipe expansion and contraction. At least 0.35 inches deflection shall be maintained under all conditions.

C. Flexible synthetic rubber connectors shall be used to connect all piping to all isolated equipment. Flexible synthetic rubber connectors shall be fabricated using peroxide cured EPDM synthetic rubber and Kelvar tire cord reinforcement and shall be Mason Industries Safeflex of the most current design. Resilient connectors shall be selected for the pressure rating and temperature rating appropriate for the particular piping and pipe contents. Where synthetic EPDM flexible connectors are not permitted by code due to pipe contents and/or pressures provide swing pipe connectors changing direction a minimum of 3 times before joining isolated equipment. Swing connections should be made within approximately 6 feet of the isolated equipment.

D. Drain connections from isolated equipment to floor drains shall be at least 1" free from drain or use rubber hose.

3.7 ISOLATION OF FRACTIONAL HORSEPOWER EQUIPMENT:

A. All fractional horsepower fans, pumps, etc., which are mounted on or suspended from floors that are not on-grade shall be isolated with neoprene-in-shear isolators furnished by the vibration isolation supplier except where such isolators are furnished as an integral part of the machine.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 05 53
HVAC IDENTIFICATION

1. GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe Markers.

D. Duct Markers.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents

1. Record actual locations of tagged valves.

F. Delivery, storage, and handling.

2. PRODUCTS

2.1 NAMEPLATES

A. Equipment Mark Nameplates: Laminated three-layer plastic with engraved black letters (matching equipment mark indicated on drawings) on light contrasting background color, with minimum 3/4 inch high letters.

B. Equipment Nameplates: Factory-applied permanent nameplate indicating the manufacturer's name, model, serial number, temperature and pressure design, and any other data necessary

to conform with specified requirements. On equipment installed outdoors, nameplate shall be stamped steel or engrave plastic.

2.2 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.

B. Chart: Typewritten list that is plastic laminated and mounted in mechanical room. Valve list is to coordinate with mechanical piping schematics if provided on plans.

C. Pipe Schematics: Valve numbers are to be labeled on Engineer schematic drawings, plastic laminated and schematic shall be mounted in mechanical room.

2.3 PIPE MARKERS

A. Color: Conform to ASME A13.1, latest revision

B. Plastic Tape Pipe Markers: Minimum 1-1/2" letter size and 2-mil thickness, flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4-mil thick, manufactured for direct burial service. Provide tape with printing which most accurately indicates the type of service of buried pipe.

2.4 DUCT MARKERS

A. Plastic Tape Duct Markers: Minimum 1-1/2" letter size and 2-mil thickness, flexible, vinyl film tape with pressure sensitive adhesive backing and printed marking; minimum information indicating flow direction arrow and identification of air system being conveyed.

3. EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe and duct markers in accordance with manufacturer's instructions. Directional arrow tape shall be overlapped to ensure proper adhesion and no peeling of tape in future.

D. Identify air handling units, exhaust fans, chillers, pumps, heat generating, heat rejecting, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

E. Identify pressure reducing valves, backflow preventers, valves, and meters with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Tag automatic controls, instruments, and relays. Key to control schematic.

I. Identify piping, concealed or exposed, with plastic tape pipe markers. Identify service, flow direction, and pressure when applicable, i.e. low pressure steam, high pressure steam. Install in clear view from floor and align with axis of piping. Locations of identification not to exceed 15 feet on straight runs including risers and drops, more often in congested areas, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Provide a minimum one label per pipe per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.

J. Identify ductwork with plastic tape duct markers. Identify service, flow direction and pressure when applicable, i.e. low pressure supply air, high pressure supply air. Install in clear view from floor and align with centerline of duct. Locations of identification not to exceed 15 feet from straight runs including risers and drops, more often in congested areas, at each side of penetration of structure or wall, and at each obstruction. When several ducts from different units are located in concealed congested areas, locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions apply to this section.

1.2 DESCRIPTION OF WORK

A. This scope of services specifies the requirements and procedures for mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results. The test and balance work will be performed by the Owner's personnel. It is the Contractor's responsibility to assist as outlined below.

B. Test, adjust and balance the following mechanical systems which are shown in the construction documents.

1. Supply air systems, all pressure ranges, including variable volume and constant volume systems.
2. Exhaust air systems.
3. Hydronic systems.
4. Steam distribution systems.
5. Verify temperature control system operation.
6. Plumbing water systems (i.e. recirculation pumps, booster pumps).

C. The contractor's responsibilities are as follows:

1. Notify the Owner's Representative fourteen (14) days prior to the schedule date for balancing the system.
2. Schedule a two (2) week allowance for the testing and balancing firm to complete the testing and balancing work when scheduling completion of all work required of the Contractor by the contract documents.
3. Cooperate with the testing and balancing firm and shall make all necessary preparations for the TAB efforts.
4. Complete the following work prior to requesting the TAB effort.

    a. Clean and flush all piping systems.
    b. Leak test and make tight all piping systems.
    c. Fill all piping systems with clean water.
    d. Clean and seal all ductwork systems.
    e. Service and tag all equipment.

f. Set and align all motors and drives.
g. Start up and prove all equipment and systems.
h. Make preliminary settings on all control devices and have all systems operational.
i. Operate all systems successfully for twenty-four (24) hours minimum.

5. Lubricate all motors and bearings.
6. Check fan belt tension.
7. Check fan rotation.
8. Patch insulation, ductwork and housing, using materials identical to those removed 9.
9. Seal ducts and piping, and test for and repair leaks.
10. Seal insulation to re-establish integrity of the vapor barrier.
11. Attend a coordination meeting prior to the balancing of the system and a coordination meeting following the balancing of the system.
12. Provide a complete set of as-built drawings prior to the TAB effort.
13. Provide craftsmen of the proper trade to work with the TAB firm to make adjustments and installation changes as required.
14. Change out fan sheaves when and if required by the TAB firm.
15. Dedicate the resources to accommodate all changes identified by the test and balance firm in a timely manner.
16. If a significant rebalance (Owner's determination) of the HVAC system is required due to the Contractor's failure to properly install and check out the HVAC system, the cost of rebalancing the system shall be borne by the Contractor.

1.3 PRE-BALANCING CONFERENCE

A. Prior to beginning of the testing, adjusting and balancing procedures, a conference with the Owner's representative, Engineer and the Test and Balance Agency's representative will be held. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting and balancing.

1.4 SEQUENCING AND SCHEDULING OF SERVICES

1.5 Test, adjust and balance the air conditioning systems during summer season and heating systems during winter season. This includes at least a period of operation at outside conditions within 5 deg. F wet bulb temperature of maximum summer design condition, and within 10 deg. F dry bulb temperature of minimum winter design conditions. Take final temperature readings during seasonal operation.

2. PART 2 – PRODUCTS

2.1 PRODUCTS (Not applicable)

3. PART 3 – EXECUTION

3.1 GENERAL (Not applicable)

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 07 13
DUCTWORK INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Ductwork insulation.

B. Insulation jackets.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

C. Delivery, Storage, and Handling.

D. Quality assurance.

1. Materials: ASTM E84 Flame spread/smoke developed rating of 25/50 or less.

E. Qualifications.

1. Applicator: Company specializing in performing the work of this section with minimum three years experience.

F. Environmental requirements.

1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
2. Maintain temperature during and after installation as recommended by the manufacturer.

2. PRODUCTS

2.1 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible blanket.

1. 'K' value: ASTM C518, 0.30 at 75 degrees F.

2. Maximum service temperature: 250 degrees F.
3. ASTM C1104 Water Vapor Sorption less than 5% by weight
4. Density: 1.5 lb/cu ft.

B. Vapor Barrier Jacket

1. Vapor Retarder Jacket: FSK or PSK confirming to ASTM C 1136 Type I, II.
2. Moisture vapor transmission: ASTM E96; 0.02 perm maximum.
3. Secure with pressure sensitive tape.

C. Vapor Barrier Tape

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

D. Tie Wire: Annealed steel, 16 gage (1.5 mm).

2.2 GLASS FIBER, RIGID

A. Insulation: ASTM C612; rigid, noncombustible blanket.

1. 'K' value: ASTM C518, 0.23 at 75 degrees F.
2. Maximum service temperature: 250 degrees F.
3. Maximum moisture absorption: less than 3 percent by volume.
4. Density (concealed locations): 3.0 lb/cu ft.
5. Density (exposed locations): 6.0 lb/cu ft.

B. Vapor Barrier Jacket

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with pressure sensitive tape.

C. Vapor Barrier Tape

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive acrylic based adhesive.

2.3 EXTERIOR DUCT INSULATION

A. Laminated Cellular Foam; closed cell foam insulation with metal covering.

1. 'K' ('ksi') Value: ASTM C177 or C518; 0.25 at 75 degrees F.

2. Minimum Service Temperature: -297 degrees F.
3. Maximum Service Temperature: 180 degrees F.
4. Maximum Moisture Absorption: ASTM D209; 0.2 percent by volume.
5. Moisture Vapor Transmission: ASTM E96; 0.05 perm-inches.
6. Connection: Waterproof vapor barrier adhesive.
7. Armaflex Armatuff Sheet Insulation or equivalent.

B. Polyisocyanurate Foam Sheathing: ASTM C1289; Foil-faced uniform closed-cell board. Johns Manville AP Foil-Faced or equivalent.

1. 'R' Value: 9.0 at 1-1/2" board thickness.
2. Minimum Service Temperature: -100 degrees F.
3. Maximum Service Temperature: 250 degrees F.
4. Moisture Vapor Transmission: ASTM E96; 0.03 perm-inches.
5. Connection: Waterproof vapor barrier adhesive.
6. Field applied jacketing: MFM FlexClad 400 or equivalent; 40 mil thickness.

a. Aluminum jacket with high-density cross-linked polymer film.
b. Aggressive Asphalt adhesive.

3. EXECUTION

3.1 EXAMINATION

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

C. Continue insulation through walls, sleeves, hangers, and other duct penetrations.

D. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

E. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.

F. Secure insulation without vapor barrier with staples (staples only work well when there is a facing present), tape, or wires.

G. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.

H. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

I. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

J. Do not overtighten and/or compress flexible glass fiber duct insulation.

K. At duct access doors or other openings, insulation shall be properly framed and finished.

L. Take adequate pre-cautions to assure that the duct insulation does not get wet if installed before the building is enclosed

M. Provide All Service Jacket on duct insulation to be painted.

N. Duct wrap on horizontal ducts shall be pinned on the bottom and sides of the duct at 18" intervals to prevent sagging.

O. Do not insulate until duct leakage test is complete and acceptable.

P. At connections to equipment such as VAV boxes, all collars, reheat coils, coil return bends shall be insulated as the adjacent duct. All components in contact with 55F supply air shall be insulated and a vapor barrier installed.

Q. Provide neatly beveled edge at interruptions of insulation. Coat bare edges of insulation with mastic or sealant to prevent delamination.

R. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.

S. Install corner angles on external corners of insulation on ductwork in exposed mechanical or finished spaces before covering with jacketing.

T. Exterior Insulation Application:

1. Laminated closed cell foam:

a. Install in accordance with manufacturer's recommendation.

b. Utilize product compliant adhesives or pre-applied pressure sensitive adhesives.
c. Cover seams with product compliant seal tape.

2. Polyisocyanurate:

a. Install in accordance with manufacturer's recommendation.
b. Use product compliant adhesive for board installation
c. Taper insulation on top of ductwork to allow positive drainage.
d. Field-apply jacketing using pressure-sensitive adhesive and hand roller.
e. Install jacketing continuous across bottom of ductwork extending minimum 6" up each side of duct. Pin duct bottoms over 36" in width.

3.3 GLASS FIBER DUCTWORK INSULATION SCHEDULE

Ductwork Application:	**Type:**	**Thickness:**	**Vapor Barrier Required (Y/N):**
Exposed rectangular supply air duct in mechanical rooms and chases	Rigid	2"	Y
Exposed round supply air duct in mechanical rooms	Flexible	2"	Y
Exposed rectangular and round exhaust air duct	None required unless shown on plans		
Exposed rectangular and round supply air duct upstream of terminal units	Flexible	2"	Y
Exposed rectangular supply air duct downstream of terminal units	Flexible	2"	Y
Exposed round supply air duct downstream of terminal units	Flexible	2"	Y
Concealed rectangular and round supply air duct upstream of terminal units	Flexible	2"	Y
Exterior Ductwork	Exterior	2"	Y
Concealed exhaust air duct	None required unless shown on plans		

Schedule Notes:

A. All ductwork in mechanical rooms shall be insulated as though it were "Exposed".

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 07 16
HVAC EQUIPMENT INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Equipment insulation.

B. Jacketing and accessories.

C. Breeching insulation.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

C. Quality Assurance.

1. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723.

D. Delivery, Storage, and Handling.

E. Environmental Requirements

1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
2. Maintain temperature during and after installation for minimum period of 24 hours.

2. PRODUCTS

2.1 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible.

1. 'k' ((btu*in)/(hr*ft^2*deg F)) value : ASTM C335

Temperature (degrees F)	Maximum 'k' value (btu*in)/(hr*ft^2*deg F))
75	0.23
100	0.24
150	0.25
200	0.28
300	0.34
400	0.42
500	0.51

2. Maximum service temperature: 250 degrees F.
3. Maximum moisture absorption: 0.2 percent by volume.
4. Density: 2.0 lb/cu ft.

B. Vapor Barrier Jacket

1. ASTM C921, kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

D. Vapor Barrier Lap Adhesive: compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.2 JACKETS

A. Canvas Jacket

1. Fabric: ASTM C921, 6 oz/sq yd, plain weave cotton treated with dilute fire retardant lagging adhesive.
2. Lagging Adhesive: Compatible with insulation.

B. Aluminum Jacket: ASTM B209.

1. Thickness: 0.040 inch.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: PVC pre molded fittings.
5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

3. EXECUTION

3.1 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Painting of cellular foam insulation is not allowed.

C. Do not insulate factory insulated equipment.

D. On exposed equipment, locate insulation and cover seams in least visible locations.

E. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

F. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

G. Insulated dual temperature equipment or cold equipment containing fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.
2. Finish with glass cloth and vapor barrier adhesive.
3. Insulate entire system.

H. For insulated equipment containing fluids above ambient temperature:

I. Provide standard jackets, with or without vapor barrier, factory applied or field applied.

1. Finish with glass cloth and adhesive.
2. For hot equipment containing fluids do not insulate flanges and unions, but bevel and seal ends of insulation.

J. Inserts and Shields:

1. Application: equipment 1-1/2 inches diameter or larger.
2. Shields: galvanized steel between hangers and inserts.
3. Insert location: between support shield and equipment and under the finish jacket.
4. Insert configuration: minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert material: ASTM C640 cork, hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

K. Finish insulation at supports, protrusions, and interruptions.

L. For equipment in mechanical equipment rooms or in finished spaces, finish with jacket sized for finish covering.

M. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.

N. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

3.3 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 GLASS FIBER, FLEXIBLE INSULATION SCHEDULE

A. Heating Systems

Equipment:	Thickness (inches):
Air separators	2"

END OF SECTION

SECTION 23 07 19 - HVAC PIPING INSULATION

1. GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, and UL 723.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

F. Environmental requirements

1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
2. Maintain temperature during and after installation for minimum period of 24 hours.

2. PRODUCTS

2.1 GLASS FIBER

A. Insulation: ASTM C547; rigid molded, noncombustible.

1. 'k' ((btu*in)/(hr*ft^2*deg F)) value : ASTM C335

Temperature (degrees F)	Maximum 'k' value (btu*in)/(hr*ft^2*deg F))

75	0.23
100	0.24
150	0.25
200	0.28
300	0.34
400	0.42
500	0.51

2. Minimum Service Temperature: 0 degrees F.
3. Maximum Service Temperature: 1000 degrees F.
4. Maximum Moisture Absorption: 0.2% by volume.

B. Vapor Barrier Jacket

1. ASTM C1136, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perms.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Vapor Barrier Lap Adhesive: MIL-A-3316C, Class 2, Grade A compliant. Compatible with insulation. VOC Limit 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Insulating Cement: ASTM C195; hydraulic setting on mineral wool. VOC Limit 70 g/L (multipurpose construction adhesive).

E. Fibrous Glass Fabric: Cloth, untreated; 9 oz/sq yd weight with 1.0 lb/cu ft density blanket.

F. Indoor Vapor Barrier Finish: Vinyl emulsion type acrylic, compatible with insulation, white color. VOC Limit 50 g/L.

2.2 JACKETS

A. PVC Plastic

1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, white color.

    a. Minimum Service Temperature: 0 degrees F.
    b. Maximum Service Temperature: 150 degrees F.
    c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
    d. Maximum Flame Spread: ASTM E84; 25.
    e. Maximum Smoke Developed: ASTM E84; 50.
    f. Thickness: 20 mil.
    g. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.

2. Covering Adhesive Mastic: Compatible with insulation and PVC jacket. VOC Limit 50 g/L according to 40 CFR 59, Subpart D (EPA Method 24).

B. Aluminum Jacket: ASTM B209.

1. Thickness: 0.040 inch.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: PVC pre molded fittings.
5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

3. EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Painting of cellular foam insulation is not allowed.

C. On exposed piping, locate insulation and cover seams in least visible locations. For cellular foam insulation tape ALL visible seams with tape matching insulation color.

D. Fiberglass insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.
2. Insulate fittings, joints, flanges, unions, strainers, flexible connectors, and valves with molded insulation of like material and thickness as adjacent pipe. PVC or aluminum covers are required in all exposed locations as in mechanical rooms.
3. Finish with glass cloth and vapor barrier adhesive.
4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Cellular foam insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

1. Insulate fittings, joints, flanges, unions, strainers, flexible connectors, and valves with molded insulation of like material and thickness as adjacent pipe. PVC or aluminum covers are required in all exposed locations as in mechanical rooms.
2. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
3. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

F. Fiberglass insulated pipes conveying fluids above ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. PVC covers are required in all exposed locations.
3. Finish with glass cloth and adhesive.
4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
5. For hot piping conveying fluids, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
6. For steam and condensate piping, insulate flanges and unions.

G. Inserts and Shields:

1. Refer to Section 23 05 29 for additional information.
2. Application: Piping 1 inch diameter or larger.
3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
4. Insert Location: Between support shield and piping and under the finish jacket.
5. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
6. Insert Material: ASTM C640 cork, hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

7. Provide inserts and/or shields per manufacturer recommendations for cellular foam insulation applications in order to maintain continuous insulation throughout the pipe system. The removal of sections of cellular foam insulation to accommodate pipe supports is not acceptable. Manufacturer products specifically designed for supporting insulation and maintaining the integrity of the insulation system at pipe hanger locations, such Armaflex Armafix Insulation Pipe Hangers, are acceptable.

H. Finish insulation at supports, protrusions, and interruptions.

I. For pipe exposed below 6 feet above finished floor, finish with PVC jacket and PVC fitting covers.

J. For piping exposed in mechanical rooms below 6 feet above finished floor, finish with aluminum jacket and aluminum fitting covers.

K. All valves in insulated systems shall have valve stem extensions. Insulation installer shall notify the contractor and Owner if valves without stem extensions are encountered. All valves without stem extensions in areas where stem extensions are required shall be replaced.

L. Install insulation blanket on steam and condensate valves.

M. In Mechanical Rooms, insulate all heat piping and accessories. All accessories shall be insulated with removable covers.

N. Provide removable covers and insulation on strainers and manual or automatic flow control valves

O. Provide insulation clearance and access to valves and fittings in hangers and from structure and other equipment. Insulation shall be continuous through all hangers and supports. Refer to Section 23 07 19.

3.3 GLASS FIBER INSULATION SCHEDULE

A. Heating Systems

PIPING SYSTEM:	PIPE SIZE:	THICKNESS:
Heating Water Supply and Return	1-1/4" & smaller	1-1/2"
Heating Water Supply and Return	1-1/2" & larger	2"
Air Terminal Unit Reheat Coil Return Bends	1-1/4” & smaller	1-1/2”
Air Terminal Unit Reheat Coil Return Bends	1-1/2” & larger	2”

Low Press. (15 psig) Steam/Cond. Piping	2-1/2" & smaller	2-1/2"
Low Press. (15 psig) Steam/Cond. Piping	3" & larger	3"

END OF SECTION

SECTION 230800 - MECHANICAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Validation of proper installation of Division 23 systems and equipment

B. Systems and equipment testing and startup

C. Equipment performance verification

D. Functional testing of control systems

E. Documentation of tests, procedures and installations

1.2 SCOPE INCLUDES

A. Systems to be commissioned include the following:
   1. Rooftop Unit Systems
   2. Dedicated Outdoor Air Systems
   3. Exhaust Systems
   4. Heat Recovery System
   5. Variable Refrigerant Flow Systems
   6. Energy Management and Control Systems
      a. Building Automation System
   7. Life Safety Systems
      a. HVAC Equipment Shutdown via Fire Alarm

1.3 RELATED DOCUMENTS

A. Commissioning Plan - This plan is part of the Contract Documents and outlines many responsibilities, procedures and tasks throughout the commissioning process.

B. Section 019113 – General Commissioning Requirements

C. Section 260800 – Electrical Commissioning Requirements

D. Division 23 Sections - Individual Sections stipulate installation, startup, warranty and training requirements for the system or device specified in that Section.

1.4 REFERENCES

A. ASHRAE Guideline 0-2013: The HVAC Commissioning Process.

B. ANSI/NEBB S110-2019 - Whole Building Technical Commissioning of New Construction

1.5 GENERAL DESCRIPTION

A. Commissioning is a process to assure all building systems are installed and perform interactively according to the design intent; the systems are efficient, cost effective and meet the Owner's operational needs; the installation is adequately documented. Commissioning serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance building systems from installation to fully optimized operation.

B. The Commissioning Authority will work with the Contractor and Design Engineer to coordinate, oversee, and document the commissioning process during the Construction Phase of this project.

C. This Section defines responsibilities of the Contractor to facilitate the commissioning process particularly during the Construction Phase of the project.

1.6 DEFINITIONS

A. Refer to specification section 019113 for definitions related to the commissioning process.

1.7 DOCUMENTATION

A. Contractor shall send Commissioning Authority one copy of the following per the procedures specified in other sections of the Specification:

1. Shop drawings and product data related to systems and equipment to be commissioned on this project. CxA will review and incorporate comments via the Design Engineer.
2. Initial draft of equipment startup plan checklists along with manufacturers' startup procedures. CxA will assist in development and recommend approval.
3. System Test Reports. CxA will review and compile prior to FPT.
4. System certificate of readiness including completed equipment startup forms along with the manufacturers' field or factory performance test documentation. CxA will review and approve prior to FPT.
5. Completed Test and Balance Reports. CxA will review and approve prior to FPT.

1.8 SEQUENCING AND SCHEDULING

A. Systems can be in various stages of the commissioning process where appropriate, in order to expedite close out of the facility. The CxA and Contractor shall cooperate to schedule Cx tasks to minimize the duration of Cx activities. Sequential priorities shall be followed per the Cx Plan.

B. Commissioning Schedule - Contractor shall incorporate the commissioning process into the project schedule. Startup, TAB and FPT shall be itemized as applicable for each system. Durations for each task shall be coordinated with the CxA.

1.9 COORDINATION MANAGEMENT PROTOCOLS

A. Coordination responsibilities and management protocols relative to Cx are initially defined in the Cx Plan but will be refined and documented at the commissioning scoping meeting. Contractor shall have input to the protocols and all parties will commit to scheduling obligations. The CxA will record and distribute notes from the meeting.

1.10 CONTRACTOR RESPONSIBILITIES

A. Construction Phase

1. Include commissioning requirements in price and plan for work.
2. Attend scoping and coordination meetings scheduled by the CxA.
3. Remedy deficiencies identified during the construction period.
4. Prepare and submit required draft forms and equipment information requested by the CxA. Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA.
5. Assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
6. Provide limited assistance to the CxA in preparing the specific functional performance test procedures. Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
7. Thoroughly complete and inspect installation of systems and equipment in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this Section.
8. Startup systems and equipment prior to verification and performance testing by the CxA. Startup procedures shall be in accordance with Contract Documents, reference or industry standards, and specifically Part 3 of this Section.
9. Record startup and test procedures on startup forms and checklists and certify the systems and equipment have been started and tested in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this Section. Each form shall be signed and dated by the individual responsible for the startup or test.

10. Complete pre-approved startup checklists and submit along with other installation certification documentation such as certificate of readiness, warranties, test results, etc.
11. Schedule and coordinate Cx efforts required by appropriate subcontractors and vendors.
12. Demonstrate the systems as specified.
13. Certify systems have been installed and are operating per Contract Documents through certificates of readiness.
14. Maintain an updated set of record documentation.
15. Copy CxA on indicated documentation.

B. Acceptance Phase

1. Assist CxA in verification and performance testing. Assistance will generally include the following:
   a. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
   b. Manipulate systems and equipment to facilitate testing.
   c. Manipulate control systems to facilitate verification and performance testing.
2. Correct any work not in accordance with Contract Documents and non-conformances included in the commissioning issues log.

C. Warranty Phase

1. Provide warranty service.
2. Correct any deficiencies identified.
3. Update record documentation to reflect any changes made throughout the Warranty Phase.

1.11 CONTROLS CONTRACTOR RESPONSIBILITIES

A. Sequences of Operation Submittals. The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:

1. All interactions and interlocks with other systems.
2. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
3. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
4. Start-up sequences.

5. Warm-up mode sequences.
6. Normal operating mode sequences.
7. Unoccupied mode sequences.
8. Shutdown sequences.
9. Capacity control sequences and equipment staging.
10. Temperature and pressure control: setbacks, setups, resets, etc.
11. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
12. Effects of power or equipment failure with all standby component functions.
13. Sequences for all alarms and emergency shut downs.
14. Seasonal operational differences and recommendations.
15. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
16. Schedules, if known.
17. Include commissioning requirements in price and plan for work.

B. Assist and cooperate with the CxA in the following manner:

1. Using a skilled technician who is familiar with this building, execute the functional testing of the controls system as specified for the controls. Assist in the functional testing of all equipment specified in Part 3 of this specification.
2. Execute all control system trend logs specified in Part 3 of this specification.

1.12 CONTRACTOR NOTIFICATION

A. Contractor shall completely install, thoroughly inspect, startup, test adjust and balance systems and equipment. All activities shall be documented on specified forms. Contractor shall notify Design Engineer, Owner and CxA via the certification of readiness that systems are complete and ready for verification and functional performance testing.

B. Contractor shall notify CxA at least 10 business days in advance of any tests or startups. CxA shall witness selected tests and startups.

1.13 STARTUP CHECKLISTS

A. Startup checklists for each type of equipment and system shall be submitted to CxA for approval prior to startup. The forms shall be designed by the appropriate subcontractors or vendors to meet the requirements of the Contract Documents. Forms shall be developed for the specific equipment being installed for this project.

B. Startup checklists shall generally include the following for each (as applicable):

1. Project specific designation, location and service

2. Pertinent nameplate data
3. Indication of the party performing the test
4. Field for signature of the startup technician along with the date
5. Clear explanation of the observation, test, measurement, etc. with a pass/fail indication and a record of measurement parameters
6. Checklist space indicating all O&M instructions, warranties, and record documents have been completed and submitted.
7. Checklist space that proper maintenance clearances have been maintained
8. Checklist space indicating that any required special tools and/or spare tools were turned over to the Owner
9. Checklist space indicating that required prerequisite equipment and systems were successfully started.

C. Startup checklists shall incorporate the manufacturer-specified procedures. Contractor shall compile the startup and checkout procedures indicated in the manufacturer's documentation prior to designing the forms. Include specified acceptance criteria as applicable. The manufacturer's startup and checkout procedures shall be submitted to the CxA along with the draft startup checklists.

D. Completed startup plans for all pieces of equipment included in a system shall be submitted to CxA prior to verification and performance testing.

E. See specification 019113 for additional information regarding Startup and Prefunctional Checklists.

1.14 FUNCTIONAL PERFORMANCE TESTING

A. Participation: CxA will coordinate, test and/or witness functional performance tests after the successful startup and documentation of systems and equipment is complete. Contractor shall assist, as described above, with manipulation of the systems or equipment; provision of supporting equipment or materials (lifts, ladders, specialty test equipment, etc.); and on the spot remediation of minor identified deficiencies.

B. Detailed Test Forms: CxA will prepare detailed testing procedures and forms to conduct and document the FPT. These will be developed during the Construction Phase and completed during the Acceptance Phase.

C. Completeness: All systems must be complete and ready for FPT. TAB work must be complete and the control systems must be tested and started for the respective system or component.

D. Test Documentation: CxA will record test results on the forms developed for the testing. CxA will Pass or Fail the testing and record the date and time of the test. Deficiencies shall clearly indicate when the test has failed. CxA shall recommend acceptance of the system or component after all related testing is successfully complete.

E. Deficiencies and Retesting: When deficiencies are identified during testing, depending on their extent or magnitude, they can be corrected during the test and the testing can

continue to successful completion. Significant deficiencies will fail the test and require retesting of the affected portions of the test. The CxA will subsequently track the resolution of the deficiency via the Project Deficiency List. All tests shall be repeated until successful completion.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. This Section outlines specific startup, checkout, and functional testing requirements for systems and equipment. Generally, these procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct. These requirements along with those specified in the individual Section provide a minimum guideline for development of startup procedures, checklists and tests. Contractor shall synthesize these requirements with that of the manufacturer's and/or applicable codes and standards to develop specific and itemized startup procedures specific to that installed on this project.

B. Refer to all Division 23 Specifications for tests performed on installed equipment and systems.

3.2 STARTUP

A. The HVAC mechanical and controls contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 019113. The Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning authority or Owner.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA, Contractor, and Owner. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all startup plan checklists as soon as possible.

3.3 VALVES – STARTUP/CHECKOUT

A. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.

B. Verify actuators are properly installed with adequate clearance.

3.4 METERS AND GAUGES – STARTUP/CHECKOUT

A. Adjust faces of meters and gages to proper angle for best visibility.

B. Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint. For meters and gauges requiring temporary manual connection of read-out device, such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.

C. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.5 MECHANICAL IDENTIFICATION – STARTUP/CHECKOUT

A. Verify all valve tags, piping, duct and equipment labeling corresponds with drawings and indices and meets required Specifications. Correct any deficiencies for all piping and duct systems.

B. Adjusting: Relocate any mechanical identification device that becomes visually blocked by work from this Division or other Divisions.

C. Cleaning: Clean face of identification devices and frames of valve charts.

3.6 MECHANICAL INSULATION – STARTUP/CHECKOUT

A. Examine all systems and equipment that are specified to be insulated. Patch and repair all insulation damaged after installation. Ensure the integrity of vapor barrier around all cold surfaces.

3.7 PIPING – STARTUP/CHECKOUT

A. This applies to all piping systems installed including underground site utilities.

B. Inspect all piping for proper installation; adequate support with appropriate vibration isolation where applicable; and adequate isolation valves for required service.

C. Flush all piping and clean all strainers.

D. Ensure adequate drainage is provided at low points and venting is provided at high points. Ensure air is thoroughly removed from the system as applicable.

E. Ensure all piping is adequately supported and anchored to allow expansion. Bump across the line pumps and inspect for excessive pipe movement.

F. Pressure and/or leak test all applicable systems in accordance with requirements in Specifications, ASME B31.1, and B31.9 as applicable.

G. Sterilize applicable piping systems as specified and as required by regulatory authorities.

H. Submit reports that document the testing results with certification of the results.

I. Verify the operation of safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.

J. Set and adjust fill pressure and level controls to the required setting.

3.8 AC MOTORS – STARTUP/CHECKOUT

A. Verify proper alignment, installation and rotation.

B. Measure insulation resistance, phase balance, and resistance to ground.

C. Verify properly sized overloads are in place.

D. Measure voltage available to all phases. Measure amps and RPM after motor has been placed in operation under load.

E. Record all motor nameplate data.

3.9 VARIABLE SPEED DRIVES – STARTUP/CHECKOUT

A. General: Provide the services of a factory-authorized representative to test and inspect equipment installation, provide startup service and to demonstrate and train Owner’s personnel.

B. Startup Checks: Perform the following checks before startup and as specified in manufacturer's startup instructions:

1. Check for shipping damage.
2. Perform a point-to-point continuity test for all field installed wiring interconnections. Verify terminations of field installed wiring.
3. Check for proper torque on connections.
4. Verify use of shielded cable where specified and check that shields have been terminated properly.
5. Verify grounding.
6. Check motor nameplate against drive input rating.
7. Manually rotate motor shaft to ensure free rotation.
8. Check that motor leads are not grounded.

C. Starting Procedures: Follow the manufacturer’s written procedures with the following as a minimum:

1. Ensure device and system which drive is serving is configured to withstand the device operation specified below.
2. Adjust the minimum voltage to enable starting but not to draw excessive power at start.
3. Adjust the Volts/Hz to proper setting.
4. Adjust the acceleration and deceleration rates to the specified times.

5. Adjust current limiting to coordinate with the overcurrent device and protect the motor.
6. Set the maximum and minimum speed.
7. Manually ramp fan speed from minimum to maximum and check for excessive noise and vibration.
8. Determine any critical speeds to avoid and set these in the drive.
9. Verify proper motor rotation in both, Normal and Bypass (if applicable) modes.
10. Record the motor terminal voltage.
11. Verify and document proper setup of redundant drives.
12. Verify and document proper operation of bypasses.

3.10 INDOOR AIR HANDLING UNITS – STARTUP/CHECKOUT

A. Inspect the field assembly of components and installation of indoor air handling units (AHU) including piping, ductwork and electrical connections.

B. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.

C. Adjust and lubricate dampers and linkages for proper damper operation.

D. Ensure field fabricated unit sections are properly connected within acceptable tolerances.

E. Seal all penetrations air tight and ensure access doors seat tightly.

F. Verify unit is secure on mountings and supporting devices and connections for piping, ductwork and electrical are complete.

G. Verify proper thermal overload protection is installed in motors, starters and disconnects.

H. Ensure vibration isolation integrity and the connections to it are maintained throughout the AHU installation.

I. Refer to AC Motors in this Section.

J. Disconnect fan drive from motor and verify proper motor rotation direction; verify fan wheel free rotation; and verify smooth bearing operations. Reconnect fan drive system, align belts and install belt guards. Rotation shall be checked with VFD operating in normal and bypass modes (if applicable).

K. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.

L. Comb coil fins for parallel orientation.

M. Install clean filters.

N. Ensure condensate drains properly and trap is adequate.

O. Stroke all valves and dampers to ensure free and full travel.

P. Pressure test units as required in the Specification.

Q. Refer to Section 230990 Testing, Adjusting, and Balancing for detailed requirements for testing, adjusting, and balancing air handling systems.

R. Refer to Section 230900 HVAC Instrumentation and Controls for detailed requirements for starting the controls related to the air handling systems.

3.11 FANS – STARTUP/CHECKOUT

A. Inspect the field assembly of components and installation of fans including ductwork and electrical connections.

B. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum fan wheel, fan cabinet and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.

C. Adjust and lubricate dampers and linkages for proper damper operation.

D. Verify unit is secure on mountings and supporting devices and connections for ductwork and electrical are complete.

E. Verify proper thermal overload protection is installed in motors, starters and disconnects.

F. Ensure vibration isolation integrity and the connections to it are maintained with the fan installation.

G. Refer to AC Motors in this Section.

H. Disconnect fan drive from motor and verify proper motor rotation direction; verify fan wheel free rotation; and verify smooth bearing operations. Reconnect fan drive system, align belts and install belt guards. Rotation shall be checked with VFD operating in normal and bypass modes (if applicable).

I. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.

J. Stroke all dampers to ensure free and full travel.

K. Refer to Section 230990 Testing, Adjusting, and Balancing for detailed requirements for testing, adjusting, and balancing fans.

L. Refer to Section 230900 HVAC Instrumentation and Controls for detailed requirements for starting the controls related to the fans.

3.12 METAL DUCTWORK – STARTUP/CHECKOUT

A. Leakage Tests: Refer to Section 233113 Ductwork for duct testing requirements.

B. Clean ductwork internally of dust and debris unit by unit as it is installed. Clean external surfaces of foreign substances, which might cause corrosive deterioration of metal or where ductwork is to be painted might interfere with painting or cause paint deterioration.

C. Strip protective paper from stainless ductwork surfaces and repair finish wherever it has been damaged.

D. Temporary Closure: Provide temporary closure at ends of ducts, which are not connected to equipment or air distribution devices at time of ductwork installation. Use polyethylene film or other covering that will prevent entrance of dust and debris until connections are completed.

E. Balancing: Refer to Section 230990 Testing, Adjusting, and Balancing for air distribution balancing of metal ductwork. Seal any leaks in ductwork that become apparent in balancing process.

3.13 DUCTWORK ACCESSORIES – STARTUP/CHECKOUT

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories as required to obtain proper operation and leak proof performance.

1. Adjusting: Adjust ductwork accessories for proper settings. Install fusible links in fire dampers and adjust for proper action.
2. Label access doors in accordance with Division 23 specification sections.
3. Mark final positioning of manual dampers as specified in Section 230990 Testing, Adjusting, and Balancing.

B. Fire Damper Testing: For every fire damper, remove the fusible link and verify the damper operates freely and closes tightly. Reinstall the fusible link.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.14 CONTROL SYSTEMS – STARTUP/CHECKOUT

A. Startup: Refer to Section 230900 HVAC Instrumentation and Controls. This Specification generally requires manufacturer’s authorized representative to startup, test, adjust and calibrate DDC control systems and demonstrate compliance with requirements. This includes verification of sequences, normal and emergency operations, calibration, interfaces, interlocks, etc.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.15 SAV/EAV TERMINAL UNITS – STARTUP/CHECKOUT

A. Ensure unit is properly supported and that integrity of vibration isolation has been maintained where applicable.

B. Ensure the air velocity sensor is correctly installed and that inlet/outlet restrictions for accurate measurements have been met.

C. Ensure air inlet is free of obstructions. Start fans and ensure proper rotation (as applicable).

D. Measure and record motor amperage and voltage (as applicable).

E. Install new filters where required.

F. Calibrate and adjust the airflow control parameters. Set applicable minimum and maximum setpoints. Coordinate with the Building Management System (BMS) contractor as necessary to obtain flow parameters.

G. Check the heating device and control to ensure functionality and proper installation. Check stroke and range on the valve and ensure it closes and seals tightly. Ensure the coils are undamaged, combed, and vented.

H. Refer to Section 230593 Testing, Adjusting, and Balancing and coordinate work.

3.16 BOILERS – STARTUP/CHECKOUT

A. Inspect the field assembly of components and installation of boilers including piping, flue, and electrical connections.

B. Verify unit is secure on mountings, supporting devices, and connections for piping, flue, and electrical are complete.

C. Verify adequate access for maintenance.

D. Check power and control voltage

3.17 PUMPS – STARTUP/CHECKOUT

A. Check suction line connections for tightness to avoid drawing air into the pump.

B. Clean and lubricate all bearings.

C. Refer to AC Motors in this Section.

D. Check that pump is free to rotate by hand. Pump shall be free to rotate with the pump hot and cold for pumps handling hot liquids. If the pump is bound or even drags slightly do not operate the pump until the cause of the trouble is determined and corrected.

E. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing. Rotation shall be checked with VFD operating in normal and bypass modes (if applicable).

F. Clean associated strainers.

G. Once system flush is complete, remove startup strainers and affix to adjacent piping to allow confirmation of removal.

H. Check that the proper overloads have been installed in the starter and are the correct size.

I. Verify that the integrity of the vibration isolation is maintained throughout the support and the connections.

J. Align pump within manufacturer's recommended tolerances.

K. Ensure all associated piping has been cleaned, tested, and vented.

L. Start the pump per the manufacturer's instructions.

M. Check the general mechanical operation of the pump and motor.

N. Verify that all thermometers and gauges are installed, are clean and undamaged, and are functional.

O. Verify the check valve seal is appropriate.

P. Check noise and vibration levels and ensure they are within the manufacturer's recommended tolerances.

Q. Refer to Section 230593 Testing, Adjusting and Balancing for detailed requirements for testing, adjusting and balancing hydronic systems.

R. Check the Net Positive Suction Head (NPSH) is within allowable limits for the operating condition.

3.18 FUNCTIONAL TESTING

A. This section specifies the functional testing requirements for Division 23 systems and equipment. From these requirements, the Commissioning Authority (CxA) shall develop step-by-step procedures to be executed by the Contractors. The general functional testing process, requirements and test method definitions are described in Section 019113. The test requirements for each piece of equipment or system contain the following:

1. The contractors responsible to execute the tests, under the direction of the CxA
2. A list of the integral components being tested
3. Startup plan checklists associated with the components
4. Functions and modes to be tested
5. Required conditions of the test for each mode
6. Special procedures
7. Required methods of testing
8. Required monitoring

9. Acceptance criteria
10. Sampling strategies allowed

B. PREREQUISITES

The following applicable generic prerequisite checklist items are required to be completed and submitted with the equipment/system certificate of readiness and checked off by CxA prior to functional testing.

1. All related equipment has been started up and startup plan checklists submitted and approved ready for functional testing.
2. All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.
3. Piping system flushing complete and required report approved
4. Water treatment system complete and operational
5. Test and balance (TAB) complete and approved for the air and hydronic systems
6. All A/E punchlist items for this equipment corrected
7. Schedules and setpoints provided to the CxA
8. False loading equipment, system and procedures ready.
9. Sufficient clearance around equipment for servicing

C. MONITORING

1. Monitoring is a method of testing as a stand-alone method or to augment manual testing.
2. All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. At the option of the CxA, some control system monitoring may be replaced with datalogger monitoring. At the CxA's request, the controls contractor shall trend up to 20% more points than listed herein at no extra charge.
3. Trend output data must be in a spreadsheet file (Excel or similar) with time continuous down left column and point values in column(s) to the right.
4. All trends for points of a group must start at the same moment in time, unless specifically approved otherwise with the commissioning agent.

3.19 INDOOR AIR HANDLING UNITS (AHU)

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls to activate the equipment as needed.
2. HVAC mechanical contractor or vendor: assist in testing sequences as needed.
3. Electrical contractor: perform loss of power testing
4. Fire alarm contractor: assist in testing sequences as needed.
5. CxA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

1. Unit and components (fans, coils, valves, ducts, VFD)

2. Heat recovery coil, humidifier or evaporative cooling sections

C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.20.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required to Be Tested, Test Methods and Seasonal Test Requirements: The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Supply air & reset temperature control functions.	Both	Both
3. SF and exhaust fan interlocks.	Either	
4. No Cooling when there is Heating	Both	
5. Duct static pressure (SP) control.	Both	
6. Exhaust fan tracking and building SP.	Monitoring	Both
7. VFD operation on SF: modulation to minimum, control system PID, constancy of static pressure, verification of program settings, alarms, etc.	Both	[2]
8. Damper interlocks and correct modulation in all modes	Manual	
9. Temperature difference across HC & CC per specifications.	Manual	
10. Heating and cooling coils freeze protection.	Manual	[2]
11. Night low limit, morning warmup cycle.	Either	Both
12. Heat recovery operation.	Monitoring	Both
13. Verify TAB reported SF cfm with control system reading.	Manual	[2]
14. All alarms (low limits, high static, etc.).	Manual	
15. Sensor and actuator calibration checks: Duct static pressure sensor, SAT, MAT, OSAT, OSA & RA damper and valve positions, SF cfm reading with TAB, and other random checks (BAS readout against hand-held calibrated instrument or observation must be within specified tolerances)	Manual	
16. Verify schedules and setpoints to be reasonable, appropriate, and coordinated with the Owner's Project Requirements.		

[1]Design cooling season, heating season or both. "Design" means within 5° of season design or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.
[2]Seasonal test not required if seasonal conditions can be adequately simulated.
[3]Refer to Special Procedures

E. Special Procedures or Conditions

1. None

F. Required Monitoring

1. All points listed below that are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. Refer to the Monitoring section at paragraph 3.20.C for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend
For each AHU being tested:		
OAT / RAT	10	7 days
SAT and SAT setpoint	10	7 days
PHC / CC / HC LAT	10	7 days
SF speed, if variable, else status	10	7 days
EF speed, if variable, else status	10	7 days
Duct SP and SP setpoint	10	7 days
Building / Space differential pressures	10	7 days
PHV / CCV / HCV / HUV position	10	7 days
Space temperature	10	7 days
Space relative humidity	10	7 days
SA relative humidity	10	7 days

G. Acceptance Criteria

1. For the conditions, sequences and modes tested, the AHU, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
2. AHU with supporting systems shall be able to maintain the SA temperature within 1.0°F of either side of the deadband of the current setpoint without excessive hunting.
3. AHU and controls shall control the duct static pressure/airflow so that it does not drift more than an amount equal to 10% of the setpoint value to either side of the deadband without excessive hunting.
4. Space temperatures shall average within +/- 1°F of setpoint and always remain within 1°F of the ends of the deadband without excessive hunting of coil valve/heating demand, or complaints of drafts or stuffiness from occupants.
5. Space relative humidity shall average between +/- 5% RH of seasonal setpoint.
6. AHU system and controls shall maintain the space temperature and humidity within the parameters defined in the Contract Documents.

END OF REQUIREMENTS FOR AHU TEST

3.20 EXHAUST FANS FPT

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls to activate the equipment, if BAS controlled.
2. HVAC mechanical contractor or vendor: assist in testing sequences.
3. CxA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

1. Exhaust fans

C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.20.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required to Be Tested, Test Methods and Seasonal Test Requirements: The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both[1]	Required Seasonal Test
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Verify schedules and setpoints to be reasonable, appropriate, and coordinated with the Owner's Project Requirements		
3. Function at fire alarm (off, depressurization, etc.)	Manual	
4. Interlocks to building pressurization control	Manual	
5. Speed controls	Either	
6. Sensor calibration checks on any controlling temperature or pressure sensor	Manual	

[1]Refer to Special Procedures

E. Special Procedures or Conditions

1. None

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. Refer to the Monitoring section at paragraph 3.20.C for additional monitoring details

Point	Time Step (min.)	Minimum Time Period of Trend
For each fan:		
EF speed, if variable, else status	10	7 days
Space/building pressure	10	7 days
Space temperature (if applicable)	10	7 days

G. Acceptance Criteria

1. For the conditions, sequences and modes tested, the fans, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR EXHAUST FAN TEST

3.21 HEATING HOT WATER SYSTEM FPT

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls, as needed.
2. HVAC mechanical contractor or vendor: assist in testing sequences.
3. Electrical contractor: perform loss of power testing
4. CxA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

1. Heat exchangers
2. HW supply pumps
3. Heating water piping system
4. VFD on pumps

C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.20.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required to Be Tested, Test Methods and Seasonal Test Requirements: The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

	Function / Mode	Test Method Manual, Monitoring, Either or Both	Required Seasonal Test[1]
General			
1.	Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:			
2.	Optimization, capacity modulation and bypass function.	Both	Heating
3.	HW supply pump staging, bypass valve operation, and HWT reset. VFD operation: modulation to minimum, control system PID, verification of program settings, alarms, etc.	Both	Heating
4.	Check all alarms and safeties (high and low pressure and temperature, etc.), PRV and flow switch functions	Manual	
5.	Test each possible lead pump as lead pump. Test pump lockouts.	Manual	
6.	Verify heat exchanger inlet/outlet pressures with startup report and manufacturer's recommendations	Manual	
7.	Sensor and actuator calibration checks on: HWST, HWRT, pressure sensor controlling pump speed, mixing valve and other random checks (BAS readout against hand-held calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of the pressure setpoint, with a test gage)	Manual	
8.	Constancy of differential pressure (pump control parameter)	Monitoring	Heating
9.	HW plant operation on emergency power	Manual	
10.	Verify schedules and setpoints to be reasonable and appropriate		

[1]Design cooling season, heating season or both. "Design" means within 5° of season design or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.
[2]Seasonal test not required if seasonal conditions can be adequately simulated.
[3]Refer to Special Procedures

E. Special Procedures

1. False load system, if necessary.

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. Refer to the Monitoring section at paragraph 3.22.C for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend
For each heat exchanger and pump:		
HWST	10	7 days
HWRT	10	7 days

OSAT-DB	10	7 days
HWS pump current or status	10	7 days
HWS pump speed, if variable	10	7 days
HWS pump flow rate, if in BAS	10	7 days
HWS pump speed controlling parameter value	10	7 days
HWS bypass valve command	10	7 days
HHW differential pressure	10	7 days
HHW differential pressure setpoint	10	7 days
HEX Steam Control Valve output	10	7 days

G. Acceptance Criteria

1. For the conditions, sequences, and modes tested, the heat exchangers, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

2. System shall maintain the supply water setpoint to within +/- 1.0°F of the setpoint deadband without excessive hunting.

3. Pumping system and controls shall maintain the current desired pressure setpoint to within an amount equal to 10% of the setpoint value of either side of the deadband without excessive hunting.

END OF REQUIREMENTS FOR HEATING HOT WATER SYSTEM TEST

3.22

3.23 TEST AND BALANCE WORK (TAB)

A. Parties Responsible to Execute Functional Test

1. TAB contractor: perform checks using test instruments.

2. Controls contractor: operate the controls to activate the equipment.

3. CxA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

1. TAB air-side

C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.20.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

D. Purpose. The purpose of this test is to spot check the TAB work to verify that it was done in accordance with the contract documents and acceptable practice and that the TAB report is accurate.

E. The following tests and checks will be conducted. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

	Test or Check	Test Method
1.	A random sample of up to 10% the TAB report data shall be selected for verification (air velocity, air or water flow rate, pressure differential, electrical measurement, etc.). The original TAB contractor will execute the checks, witnessed by the commissioning authority. The TAB contractor will use the same test instruments as used in the original TAB work. A failure[1] of more than 10% of the selected items of a given system[2] shall result in the failure of acceptance of the system TAB report and the TAB contractor shall be responsible to rebalance the system in its entirety, provide a new system TAB report and repeat random verifications of the new TAB report.	Demonstration
2.	Verify that final settings of all valves, dampers and other adjustment devices have been permanently marked by the TAB Contractor.	Demonstration
3.	Verify that the air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all TUs taking off downstream of the static pressure sensor, the TU on the critical leg has its damper 90% or more open.	Demonstration

[1]Failure of an item is defined as follows:
For air flow of supply and return: a deviation of more than 10% of instrument reading
For minimum outside air flow: 20% of instrument reading
For temperatures: a deviation of more than 1°F
For air and water pressures: a deviation of more than 10% of full scale of test instrument reading

[2]Examples of a “system” are: the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system. Systems can be defined as smaller parts if inaccuracies in TAB work within the smaller defined system will have little or no impact on connected systems.

F. Special Procedures or Conditions

1. Rechecking shall be limited to either 10% of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

G. Required Monitoring

1. None

H. Acceptance Criteria

1. Provided in footnote to test table above.

END OF REQUIREMENTS FOR TAB TEST

END OF SECTION 230800

SECTION 23 09 00
DIGITAL CONTROL EQUIPMENT

1. GENERAL

1.01 SUMMARY

A. University of Missouri Controls Specification.

B. This section contains requirements for pneumatic, electric and digital control systems as indicated on the contract drawings.

C. Contractor is responsible for providing, installing and connecting all sensors, pneumatic actuators, control valves, control dampers, electrical components and all interconnecting pneumatic tubing and electrical wiring between these devices and up to the Direct Digital Controller (DDC).

D. DDC systems consist of Johnson Controls METASYS controllers. Contractor shall install owner provided control enclosures. Owner will provide and install controllers. After all equipment has been installed, wired and piped, Owner will be responsible for all termination connections at the DDC controller's and for checking, testing, programming and start-up of the control system. Contractor must be on site at start-up to make any necessary hardware adjustments as required.

E. Once each mechanical system is completely operational under the new control system, contractor shall make any final connections and adjustments. For controls renovation jobs, contractor shall remove all unused sensors, operators, panels, wiring, tubing, conduit, etc. Owner shall have the option of retaining any removed pneumatic controls.

1.02 RELATED SECTIONS

A. Drawings and general provisions of Contract, including General and Special Conditions apply to work of this section.

1.03 QUALITY ASSURANCE

A. Contractor's Qualifications:
   1. Contractor shall be regularly engaged in the installation of digital control systems and equipment, of types and sizes required. Contractor shall have a minimum of five years' experience installing digital control systems. Contractor shall supply sufficient and competent supervision and personnel throughout the project in accordance with General Condition's section 3.4.1 and 3.4.4.

B. Codes and Standards:
   1. Electrical Standards: Provide electrical components of control systems which have been UL-listed and labeled, and comply with NEMA standards.
   2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for control systems.
   3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
   4. NFPA Compliance: Comply with NFPA 70 "National Electric Code."

1.04 SUBMITTALS

A. Shop Drawings: Submit shop drawings for each control system, containing the following information:

B. Product data for each damper, valve, and control device.

C. Schematic flow diagrams of system showing fans, pumps, coils, dampers, valves, and control devices.

D. Label each control device with setting or adjustable range of control.

E. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

F. Provide details of faces on control panels, including controls, instruments, and labeling.

G. Include written description of sequence of operation.

H. Provide wiring diagrams of contractor provided interface and I/O panels.

I. Provide field routing of proposed network bus diagram listing all devices on bus.

2. PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Air Piping:
   1. Copper Tubing: Seamless copper tubing, Type M or L, ASTM B 88; wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment.
   2. Flex Tubing: Virgin Polyethylene non-metallic tubing, ASTM D 2737, with flame-retardant harness for multiple tubing. Use compression or push-on polyethylene fittings. Tubing used above suspended ceilings to be plenum rated per NFPA 90A. See section 3.1.b for locations where flex tubing can be used.

3. Copper to polyethylene connections shall be compression barbed fittings or solder barbed fittings.

B. Conduit and Raceway:
1. Electrical Metallic Tubing: EMT and fittings shall conform to ANSI C80.3.
2. Surface Metal Raceway and Fittings: Wiremold 500, Ivory, or approved equal.
3. Flexible Metal Conduit: Indoors, per National Electric Code for connection to moving or vibrating equipment.
4. Liquidtight Flexible Conduit: Outdoors, per National Electric Code for connection to moving or vibrating equipment.

C. Control Valves: Provide factory fabricated pneumatic or electric control valves of type, body material, and pressure class as indicated on the drawings. Butterfly style control valves are not acceptable except for two position applications. Equip control valves with heavy-duty actuators, with proper shutoff rating for each individual application.
1. Steam and Hot Water
a) Manufacturer: Do not allow KMC valves and actuators.
b) Water Service Valves: Equal percentage characteristics.
c) Steam Service Valves: Equal percentage characteristics.
d) Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
e) Valve Trim and Stems: Polished stainless steel.
f) Packing: Spring-loaded Teflon, self-adjusting.
g) Control valves should have a minimum 100 psi close-off rating for chilled water applications.
2. Hydronic Chilled Water and Heating Water

1. General:

a. The control valve assemblies shall be provided and delivered from a single manufacturer as a complete assembly. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
b. Valves shall be suitable for use in systems with glycol solution fluids.
c. Two-way valves shall have modified equal percentage characteristics. Three-way valves shall have linear characteristics.
d. Close-Off Pressure Rating: 100 psig minimum, but no less than 150% of the total system head.
e. Sizing:

1) Two-Position: Line size or size using a pressure differential of 1 psi.
2) Two-Way Modulating: 3 psig or twice the load pressure drop, whichever is higher.
3) Three-Way Modulating: Twice the load pressure drop, but not more than 5 psig.

2. Up to 3 inches:

a. Ball Valves: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats and a Tefzel ETFE or equivalent flow characterizing disc.

3. Over 3 inches:

a. Butterfly Valves: Butterfly valve body, full-lugged cast iron or ductile iron 200 psig body with a 304 stainless steel disc, EPDM seat, extended neck, meeting ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize an internal spline. The shaft shall be supported at four locations by RPTFE bushings.

1) Close-Off Pressure Rating: 200 psig bubble-tight shutoff for sizes 2" to 12"; 150 psig bubble-tight shutoff for sizes 14" and larger.

b. Globe Valves: ANSI Class 125 cast iron body, stainless steel stem, bronze plug, bronze seat, and a TFE V-ring packing.

4. Pressure Independent Hydronic Control Valves (where scheduled on drawings):

a) Control valves shall be pressure independent. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valve shall accurately control the flow from 1 to 100% full rated flow.
b) The valve bodies shall be of cast iron, steel or bronze and rated for 150 PSI working pressure. All internal parts shall be stainless steel, steel, Teflon, brass, or bonze.
c) DeltaP Valves manufactured by Flow Control Industries, Belimo P Series, Danfoss AB-QM Series, or approved equal.
d) The valves shall have pressure taps across the valve for measuring the pressure drop across the valve. The pressure taps shall have ½-inch extensions for accessibility.
e) Control valves shall be installed with unions or flanges as necessary for easy removal and replacement.
f) Valve Tag shall include the model number, AHU being served, design flow, and maximum flow for that valve.
g) The control valves shall be delivered preset to the scheduled design flow and should be capable of reaching 110% of the design flow to allow for field adjustment for capacity changes.

5. Automatic Balance Valves:

a. Valve body shall be constructed out of brass and rated for 400 PSIG working pressure.
b. Valve shall include an integrated chrome plated brass ball valve.
c. Valve body shall include two pressure\temperature ports.

d. Valve shall utilize a removable differential pressure regulating cartridge.
e. Removable differential pressure cartridge shall utilize a removable orifice plate to set the maximum flow through the valve.
f. Removable orifice plate shall be designed to maintain its size and shape while system is in operation. Additionally, the Cv through the orifice plate shall not change while the system is in operation.
g. Removable differential pressure cartridge shall feature a rolling EPDM rubber diaphragm to eliminate metal-on-metal contact and leak paths.
h. Valve body shall have the ability to accommodate a union ended tailpiece with SWTF, male NPT thread, female NPT thread connections and a union nut that can secure the tailpiece to the body of the valve to create a water-tight seal
i. Valve shall have maximum differential pressure limit of 60 psid.
j. Valve temperature range shall be from -4°F (-20°C) to 250°F (121°C).
k. Accessories: Extend pressure/temperature ports and Extended Handle
l. Bell & Gossett, Flow Design, Tour & Andersson or Griswold with removable/adjustable cartridge or approved equal.

D. Control Dampers: Ruskin CD-50 or approved equal.
1. Provide dampers with parallel blades for 2- position control.
2. Provide opposed blades for modulating control.
3. Dampers shall be low leakage design with blade and edge seals.
4. Provide multiple sections and operators as required by opening size and sequence of operations, as indicated on the contract drawings.

E. Electric Actuators: Johnson Controls, Bray, Belimo, TAC or approved equal. KMC actuators are not approved. Size electric actuators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified. If mixed air AHU has return air, exhaust air and outside air dampers that are not mechanically linked then static safety switch must be installed and wired to safety circuit. Spring return actuators should be provided on heat exchanger control valves or dampers or as specified on the drawings. Control signal shall be 0 to 10 VDC unless otherwise specified on drawings. Actuators with integral damper end switch are acceptable. For VAV reheat valves, actuators shall have a manual override capability to aid in system flushing, startup, and balancing.

F. Air and Hot Water Electronic Temperature Sensors:

1. All electronic temperature sensors shall be compatible with Johnson METASYS systems.
2. Sensors shall be 1,000 ohm platinum, resistance temperature detectors (RTDs) with two wire connections. Duct mounted sensors shall be averaging type. Contractor may install probe type when field conditions prohibit averaging type, but must receive permission from Owner's Representative.
3. Coordinate thermowell manufacturer with RTD manufacturer. Thermowells that are installed by the contractor, but are to have the RTD installed by owner, must be Johnson Controls Inc. series WZ-1000.

G. Electronic Temperature Sensors and Transmitters:
1. Chilled Water, Tower Water, Heating Hot Water, and Steam Temperature Sensors

a) General: The RTD/Temperature Transmitter/Thermowell assembly shall come as a complete assembly from a single manufacturer. The Assembly shall be suitable for use in the accurate measurement of Chilled/Tower/Hot Water and steam temperatures in a mechanical room environment.

b) Calibration: Each RTD must be match calibrated to the Transmitter via NIST traceable calibration standards. Results are to be programmed into the transmitter. Results are to be presented on report as after condition at the specified calibration points. Assembly shall not be approved for installation until Owner has received all factory calibration reports.

c) RTD:
   (1) RTD type: 2-wire or 3-wire 100 ohm platinum class A
   (2) Outside Diameter: 0.25 inch
   (3) Tolerance: +/- 0.06% Type A
   (4) Stability: +/- 0.1 % over one year.
   (5) TCR: 0.00385 (ohm/ohm/^{o}C).
   (6) RTD shall be tip sensitive.
   (7) Resistance vs. Temperature table for the RTD must be provided to the Owner.

d) Transmitter:
   (1) Transmitter shall be match calibrated to the RTD and assembled as a matched pair.
   (2) Type: 2 wire (loop powered)
   (3) Input: 2 or 3 wire 100 ohm platinum class A or class B RTD
   (4) Output: Output shall be a 4-20 mA signal linear to temperature
   (5) Calibrated Span:
      (a) Chilled Water: 30 ^{o}F to 130 ^{o}F.
      (b) Tower Water: 30 ^{o}F to 130 ^{o}F.
      (c) Hot Water: 100 ^{o}F to 250 ^{o}F.
      (d) Steam: 150 ^{o}F to 450 ^{o}F
   (6) Calibration Accuracy, including total of all errors, of the Transmitter & RTD matched pair over the entire span shall be within +/- 0.2% of the calibrated span or +/- 0.18 ^{o}F, whichever is greater.
   (7) Supply Voltage: 24 VDC.
   (8) Ambient Operating Temp.: 32 to 122 ^{o}F
   (9) Epoxy potted for moisture resistance.
   (10) Mounting: Transmitter shall be mounted in the RTD connection head.

e) Thermowell
   (1) Thermowell shall be suitable for immersion in chilled/hot water and steam.
   (2) Thermowell shall be reduced tip.
   (3) Thermowell shall be one piece stainless steel machined from solid bar stock.
   (4) Thermowell shall have 1/2” NPT process connection to pipe thred-o-let.
   (5) Thermowell Insertion depth shall be ½ the inside pipe diameter but not to exceed 10”.

f) Assembly:
   (1) Assembly configuration: Spring loaded RTD with thermowell-double ended hex-connection head.

(2) Connection head shall be cast aluminum with chain connecting cap to body, have 1/2" NPT process and 3/4" NPT conduit connections, and a sealing gasket between cap and body.

g) RTD/Temperature Transmitter/Thermowell assembly shall be the following or approved equal:
(1) Manufacturer: Pyromation, Inc.
(2) Chilled Water: RAF185L-S4C[length code]08-SL-8HN31,TT440-385U-S(30-130)F with calibration SMC(40,60)F
(3) Tower Water: RAF185L-S4C[length code]08-SL-8HN31,TT440-385U-S(5130)F with calibration SMC(55,85)F
(4) Hot Water: RAF185L-S4C[length code]08T2-SL-8HN31,TT440-385U-S(100-250)F with calibration SMC(140,180)F
(5) Steam: RAT185H-S4C[length code]08T2-SL-8HN31,TT440-385U-S(150-450)F with calibration SMC(300,350)F

H. Occupant Override: Provide wall mounted occupant override button in locations shown on drawings.

I. Low Limit Controllers: Provide unit-mounted low limit controllers, of rod-and-tube type, with an adjustable set point and a manual reset. Capillary shall be of adequate length to horizontally traverse face of cooling coil every 12". Multiple low limit controllers may be required for large coils. Controller shall have an extra set of contactors for connection to control panel for alarm status. Locate the thermostat case and bellows where the ambient temperature is always warmer than the set point.
1. Freeze Stats: Johnson Controls model A70HA-1 or approved equal.

J. Humidistats: Humidistats must be contamination resistant, capable of ±2% RH accuracy, have field adjustable calibration and provide a linear proportional signal.
1. HD20K-T91 or equivalent.

K. Humidity High Limit
1. Multi-function device that can function as a high limit or proportional override humidity controller, as stand-alone proportional controller, or a stand-alone two-position controller.
a) Johnson Controls TRUERH HL-67N5-8N00P or approved equal.

L. Carbon Dioxide Sensor:
1. Wall Mount: ACI Model ESENSE-R.
2. Duct Mount: ACI Model ESENSE-D.

M. Fan/Pump Status: Status points for fan or pump motors with a VFD must be connected to the terminal strip of the VFD for status indication.
Current switches: Current switches are required for fan and pump statuses that are not connected to a VFD. The switches must have an adjustable trip setpoint with LED indication and be capable of detecting broken belts or couplings. Units shall be powered by monitored line, UL listed and CE certified, and have a five year warranty.
1. Kele, Hawkeye or approved equal.

N. Relays Used for Fan and Pump Start/Stop: Must have LED indication and be mounted externally of starter enclosure or VFD.
   1. Kele, RIBU1C or approved equal.

O. Power Supply Used to Provide Power to Contractor-Provided Control Devices: Shall have adjustable DC output, screw terminals, overload protection and 24 VAC and 24 VDC output.
   1. Kele, DCPA-1.2 or approved equal.

P. Pressure Differential Switch:
   1. Fans: NECC model DP222 or approved equal.

Q. Differential Pressure Transmitter: Provide units with linear analog 4-20mA output proportional to differential pressure, compatible with the Johnson METASYS Systems.
   1. Water: Units shall be wet/wet differential pressure capable of a bi-directional pressure range of +/- 50 psid. Accuracy shall be +/- 0.25% full scale with a compensated temperature range of 30 to 150 deg F and a maximum working pressure of 250 psig.
   2. Install transmitter in a pre-manufactured assembly with shut off valves, vent valves and a bypass valve.
      a) Setra model 230 with Kele model 3-VLV, three valve manifold or approved equal.
   3. Air: Units shall be capable of measuring a differential pressure of 0 to 5 in. WC. Accuracy shall be +/- 1.0% full scale with a compensated temperature range of 40 to 149 deg F and a maximum working pressure of 250 psig.
      a) Setra model 267, or approved equal.
      b) Shall be installed in control panel and piped 2/3 down the duct unless shown otherwise or approved by owners representative.

R. Building Static Pressure: Transducer shall utilize a ceramic capacitive sensing element to provide a stable linear output over the specified range of building static pressure. Transducer shall be housed in a wall-mounted enclosure with LCD display. Transducer shall have the following capabilities:
   1. Input Power: 24 VAC
   2. Output: 0-10 VDC
   3. Pressure Range: -0.25 to +0.25 inches w.g.
   4. Display: 3-1/2 digit LCD, displaying pressure in inches w.g.
   5. Accuracy: +/- 1.0% combined linearity and hysteresis
   6. Temperature effect: 0.05% / deg C
   7. Zero drift (1 year): 2.0% max
   8. Zero adjust: Push-button auto-zero and digital input
   9. Operating Environment: 0 to 140 deg F, 90% RH (non-condensing)
   10. Fittings: Brass barbs, 1/8” O.D.
   11. Enclosure: High-impact ABS plastic
   12. Outside Air Sensor Pickup Port: UV stabilized thermoplastic or aluminum “can” enclosure to shield outdoor pressure sensing tube from wind effects. BAPI ZPS-ACC10- rooftop mount, wall mount, or equivalent.
   13. Transducer shall be Veris Industries Model PXPLX01S, equivalent from Setra, or approved equal.

S. High Static Pressure Limit Switch: Provide pressure high limit switch to open contact in fan circuit to shut down the supply fan when the inlet static pressure rises above the set point. Provide with an adjustable set point, a manual reset button, 2 SPST (normally closed) contacts, and ¼" compression fittings.
   1. Kele model AFS-460-DDS, or approved equal.

T. AIRFLOW/TEMPERATURE MEASUREMENT DEVICES
   1. Provide airflow/temperature measurement devices where indicated on the plans. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.
   2. The measurement device shall consist of one or more sensor probe assemblies and a single, remotely mounted, microprocessor-based transmitter. Each sensor probe assembly shall contain one or more independently wired sensor housings. The airflow and temperature readings calculated for each sensor housing shall be equally weighted and averaged by the transmitter prior to output. Pitot tubes and arrays are not acceptable. Vortex shedding flow meters are not acceptable.
   3. All Sensor Probe Assemblies
      a) Each sensor housing shall be manufactured of a U.L. listed engineered thermoplastic.
      b) Each sensor housing shall utilize two hermetically sealed, bead-in-glass thermistor probes to determine airflow rate and ambient temperature. Devices that use "chip" or diode case type thermistors are unacceptable. Devices that do not have 2 thermistors in each sensor housing are not acceptable.
      c) Each sensor housing shall be calibrated at a minimum of 16 airflow rates and have an accuracy of +/-2% of reading over the entire operating airflow range. Each sensor housing shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
         (1) Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
      d) The operating temperature range for the sensor probe assembly shall be -20° F to 160 F. The operating humidity range for the sensor probe assembly shall be 0-99% RH (non-condensing).
      e) Each temperature sensor shall be calibrated at a minimum of 3 temperatures and have an accuracy of +/-0.15° F over the entire operating temperature range. Each temperature sensor shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
      f) Each sensor probe assembly shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
      g) Each sensor assembly shall not require matching to the transmitter in the field.
      h) A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location.
   4. Duct and Plenum Sensor Probe Assemblies

a) Sensor housings shall be mounted in an extruded, gold anodized, 6063 aluminum tube probe assembly. Thermistor probes shall be mounted in sensor housings using a waterproof marine grade epoxy resin. All wires within the aluminum tube shall be Kynar coated.

b) The number of sensor housings provided for each location shall be as follows:

(1)

Area (sq.ft.)	Sensors
<2	4
2 to <4	6
4 to <8	8
8 to <16	12
>=16	16

c) Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
(1) Insertion mounted through the side or top of the duct.
(2) Internally mounted inside the duct or plenum.
(3) Standoff mounted inside the plenum.

d) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

5. Fan Inlet Sensor Probe Assemblies
a) Sensor housings shall be mounted on 304 stainless steel blocks.
b) Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
c) Mounting feet shall be constructed of 304 stainless steel.
d) The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.

6. Transmitters
a) The transmitter shall have a 16 character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics. Configuration settings and diagnostics shall be accessed through a pushbutton interface on the main circuit board. Airflow shall be field configurable to be displayed as a velocity or a volumetric rate.
b) The transmitter shall be capable of independently monitoring and averaging up to 16 individual airflow and temperature readings. The transmitter shall be capable of displaying the airflow and temperature readings of individual sensors on the LCD display.
c) The transmitter shall have a power switch and operate on 24 VAC (isolation not required). The transmitter shall use a switching power supply fused and protected from transients and power surges.
d) All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
e) The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be protected from weather and water.
f) The transmitter shall be capable of communicating with the host controls using one of the following interface options:
(1) Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire).
(2) RS-485: Field selectable BACnet-MS/TP, ModBus-RTU and Johnson Controls N2 Bus.

(3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, ModBus-TCP and TCP/IP.
(4) LonWorks Free Topology.

g) The transmitter shall have an infra-red interface capable of downloading individual sensor airflow and temperature data or uploading transmitter configuration data to a handheld PDA (Palm or Microsoft Pocket PC operating systems).

7. The measuring device shall be UL listed as an entire assembly.
8. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.
9. Manufacturer
   a) Primary flow elements, sensors, meters and transducers shall be EBTRON, Inc. Model GTx116-P and GTx116-F or approved equal.
   b) The naming of any manufacturer does not automatically constitute acceptance of this standard product nor waive their responsibility to comply totally with all requirements of the proceeding specification.

U. Electrical Requirements: Provide electric-pneumatic switches, electrical devices, and relays that are UL-listed and of type which meet current and voltage characteristics of the project. All devices shall be of industrial/ commercial grade or better. Residential types will be rejected.
   1. EP Switches: Landis & Gyr Powers, Inc. Series 265 - Junction Box Type or approved equal.
   2. Relays: Relays shall have an LED status indicator, voltage transient suppression, Closed-Open-Auto switch, plastic enclosure, and color coded wires. Kele model RIBU1C or approved equal.

V. Magnetic Flowmeter for Heating Water System:
   1. The Magnetic Flowmeter flow tube and computer/transducer shall come as a complete system assembled by a single manufacturer. The flowmeter shall be suitable for use in the accurate measurement of Heating Water flow for process control and/or utility metering, in a mechanical room environment, with a Johnson Controls EMCS system.
   2. The flowmeter shall consist of a pulsed DC electromagnetic coil incorporating Faraday's Law utilizing the flowing Water as the conductor. The flowmeter shall provide proper grounding for use in Schedule 40 steel pipe, Schedule 10S stainless steel pipe, or copper pipe as application requires.
   3. The flowmeter element should be sized to maintain maximum accuracy over the flow range of the application while keeping flow tube velocity below 15 fps at max flow. The flowmeter element shall be the flow tube, spool piece type with a non-conductive lining and no intrusions into the flow path. The flowmeter flow tube shall be suitable for direct mounting to standard ANSI flanges.
   4. The flowmeter shall have a local LCD display that indicates flow in GPM and/or Total gallons from the totalizer. The flowmeter shall be programmable/configurable via local push buttons. The flowmeter computer/transducer shall be remote mounted. The flow tube shall have a direct mounted junction box for wiring connections.
   5. The flowmeter shall have the capability to be calibrated insitu to verify proper operation and accuracies.

6. The flowmeter shall also meet the following specifications:

   a) Measures Bi-directional flow.
   b) Zero-point stability.
   c) Flow tube can withstand a full vacuum on an intermittent basis.
   d) Normal obstructions, partially opened valves, 90^0 or 45^0 elbows, and pump discharges shall require no more than 5 pipe diameters upstream and 3 pipe diameters downstream of straight pipe run for specified performance.
   e) Auto re-start after electrodes have lost wetness.
   f) Computer/transducers shall be interchangeable to multiple flow tubes without affecting the published accuracies of the meter.
   g) Computer/transducer internal electronic components, including power supply and output boards, shall be field interchangeable/exchangeable.
   h) Calibration: NIST Traceable, certificate provided with each meter.
   i) Electrode Pressure Rating: Equivalent to flow tube flange rating
   j) Minimum Conductivity: 5 mS/cm for fluid to be measured
   k) Transmitter Ambient Temp.: 122 ^{0}F
   l) Flow Tube Process Temp.: 32 ^{0}F to 140 ^{0}F for Chilled Water applications
   m) Flow Tube Process Temp.: 32 ^{0}F to 140 ^{0}F for Make Up Water applications
   n) Flow Tube Process Temp.: 32 ^{0}F to 311 ^{0}F for Hot or Dual Water applications
   o) Flow Range: +/- 0 to 30 fps
   p) Accuracy (velocity < /= 1.0 fps): +/- 0.5% of reading or +/- 0.005 fps
   q) Accuracy (velocity > 1.0 fps): +/- 0.5% of reading
   r) Analog Output: 4-20 mA, linear to flow in GPM
   s) Analog Output Accuracy: +/- 0.05% of span
   t) Repeatability: +/- 0.1%
   u) Stability: +/- 0.1%
   v) Ambient Temperature Effect: <1% per 100 ^{0}F
   w) Vibration Effect: 0.1% (remote mounted transducer)
   x) Low Flow Cutoff: settable to 0.04 fps or lower
   y) Low Flow Cutoff Analog Output: Analog output shall be 4.0 mA at flows below the low cutoff.
   z) Humidity Limits: 5-90% RH
   aa) Power Supply: 115 VAC
   bb) Power Consumption: 20 W maximum
   cc) Enclosures: NEMA 4
   dd) Flow Tube working pressure: 150 psi
   ee) Flanges: Carbon steel, ANSI Class 150#
   ff) Electrodes: Corrosion resistant Alloy C
   gg) Cable Length: As required per plans, 150 ft minimum
   hh) Cable shall be capable of empty pipe detection.
   ii) All cable shall be provided by the meter manufacturer.

7. The flowmeter shall be Foxboro IMT31A with 9500A, 9700A for high temperature, or approved equal.

8. Bids/Submittals: All bids and/or submittals must include published specifications, specific model number configurations, and operation & maintenance manuals.

9. Warranty: All parts and components as needed for the specified operation and performance shall be covered under warranty for a period of not less than two yearsrs.

3. EXECUTION

3.01 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

B. Control Air Piping:
1. All control air piping shall be copper. Exception: Flexible Tubing may be used for a maximum of two (2) feet at connections to equipment [except for steam control valves] and inside control cabinets.
2. Provide copper tubing with a maximum unsupported length of 3'-0".
3. Pressure Test control air piping at 30 psi for 24 hours. Test fails if more than 5 PSI loss occurs.
4. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support tubing neatly.
5. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system.
6. All control tubing at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel.
7. Provide pressure gages on each output device.
8. Paint all exposed control tubing to match existing.

C. Raceway: Raceway is to be installed in accordance with the National Electric Code. Use of flexible metal conduit or liquidtight flexible conduit is limited to 36" to connect from EMT to devices subject to movement. Flexible raceway is not to be used to compensate for misalignment of raceway during installation.

D. Control Wiring: Install control wiring in raceway, without splices between terminal points, color-coded. Install in a neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code.
1. Install circuits over 25-volt with color-coded No. 12 stranded wire.
2. Install electronic circuits and circuits under 25-volts with color-coded No. 18 stranded twisted shielded pair type conductor.
3. N2 communications bus wire shall be 18 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, descripted as 18-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent.

a) Metastat wiring shall be minimum 20 AWG, plenum rated, stranded, 8 conductor stranded wire.

4. FC communications bus wire shall be 22 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, descripted as 22-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent.
   a) Network sensor wiring (SA Bus) shall be 22 gauge plenum rated stranded twisted wire, 4 conductor.
5. All control wiring at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel. Label all control wires per bid documents.

E. All low voltage electrical wiring shall be run as follows:
   1. Route electrical wiring in concealed spaces and mechanical rooms whenever possible.
   2. Provide EMT conduit and fittings in mechanical rooms and where indicated on drawings.
   3. Low voltage electrical wiring routed above acoustical ceiling is not required to be in conduit, but wire must be plenum rated and properly supported to building structure.
   4. Provide surface raceway, fittings and boxes in finished areas where wiring cannot be run in concealed spaces. Route on ceiling or along walls as close to ceiling as possible. Run raceway parallel to walls. Diagonal runs are not permitted. Paint raceway and fittings to match existing conditions. Patch/repair/paint any exposed wall penetrations to match existing conditions.

F. All devices shall be mounted appropriately for the intended service and location.
   1. Adjustable thermostats shall be provided with base and covers in occupied areas and mounted 48" above finished floor to the top of the device. Tubing and/or wiring shall be concealed within the wall up to the ceiling where ever possible. Surface raceway may only be used with approval of Owners Representative. Wall mounted sensors such as CO2, RH, and non-adjustable temperature sensors shall be mounted 54” above finished floor. Duct mounted sensors shall be provided with mounting brackets to accommodate insulation. Mounting clips for capillary tubes for averaging sensors are required.
   2. All control devices shall be tagged and labeled for future identification and servicing of control system.
   3. Preheat and mixed air discharge sensors must be of adequate length and installed with capillary tube horizontally traversing face of coil, covering entire coil every 24 inches bottom to top.
   4. All field devices must be accessible or access panels must be installed.

G. Install magnehelic pressure gage across each air handling unit filter bank. If the air handling unit has a prefilter and a final filter, two magnehelic pressure gages are required.

3.02 ADJUSTING AND START-UP

A. Start-Up: Temporary control of Air Handling Units shall be allowed only if approved by the owner’s representative to protect finishes, etc., AHUs may be run using caution with temporary controls installed by contractor early in the startup process. All safeties including a smoke detector for shut down must be operational. Some means of discharge air control shall be utilized and provided by the contractor such as a temporary temperature sensor and controller located and installed by the Contractor.

B. The start-up, testing, and adjusting of pneumatic and digital control systems will be conducted by owner. Once all items are completed by the Contractor for each system, Contractor shall allow time in the construction schedule for owner to complete commissioning of controls before project substantial completion. This task should be included in the original schedule and updated to include the allotted time necessary to complete it. As a minimum, the following items are required to be completed by the Contractor for Owner to begin controls commissioning.
   1. Process Control Network
      a) The control boards and enclosures need to be installed in the mechanical rooms.
      b) The fiber optic conduit and box for the process control network needs to be installed. Once in place, Owner needs to be contacted so the length of the owner provided fiber cable can be determined and ordered, if required. Coordinate with Owner to schedule the pull in and termination of the fiber cable. Power should be in place at that time. (Fiber for the process control network is required to allow metering of utilities prior to turn on.)
   2. Heating System
      a) Pumps, heat exchangers, steam pressure reducing station, piping, control valves, steam and/or hot water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, steam regulators set to required pressure, condensate pumps operational, heating system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.
   3. Cooling System
      a) Pumps, heat exchangers, piping, control valves, chilled water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, cooling system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.
   4. VAVs-First Pass
      a) Power, (FC or N2 bus), and control wire installed before owner can make first commissioning pass. First pass includes installation of VAV controller, termination of power, control and network communication wiring.
   5. Air Handlers
      a) Prior to owner commissioning, at a minimum, the following items shall be complete: Power wiring, motor rotation check, fire/smoke dampers open, control wiring including all safeties, IO cabinet, air handler cleaned, and filters installed as required. To protect the systems from dirt, outside air with no return will be used until the building is clean enough for return air operation.
   6. VAVs-Second Pass
      a) After the air handlers are running and under static pressure control and the heating water system is operating, a second pass can be made on the VAVs to download the control program and commission controllers to verify the VAV dampers, thermostat, and reheat control valves are working properly.
   7. Exhaust and Energy Recovery Systems

a) Exhaust fans need to be operational and under control before labs can be commissioned.

8. Lab Air Controls
   a) Lab Air Controls vendor will have the same requirements as stated above for VAVs.
9. Some balance work can be done alongside the control work as long as areas are mostly complete and all diffusers are in place.

3.03 CLOSEOUT PROCEDURES

A. Contractor shall provide complete diagrams of the control system including flow diagrams with each control device labeled, a diagram showing the termination connections, and an explanation of the control sequence. The diagram and sequence shall be framed and protected by glass and mounted next to controller.
B. Contractor shall provide as built diagram of network bus routing listing all devices on bus, once wiring is complete prior to scope completion.

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATION

1. GENERAL

1.1 The sequences provided in this section are subject to minor modifications during shop drawing review phase and system start-up. These minor changes are usually due to the specific operating characteristics of the HVAC equipment actually installed and/or building dynamics. These minor sequence modifications shall be incorporated without additional charges to the Owner.

1.2 All control set points called out shall be adjustable through software.

1.3 Refer to drawings for sequences of operation.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 21 13
HYDRONIC PIPING

1. GENERAL

1.1 SECTION INCLUDES

A. Above grade pipe, fittings, and joints for:

1. Heating water piping system.
2. Equipment drains and overflows.
3. Steam piping to humidifier dispersion grid

B. Valves.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. References.

C. Submittals.

D. Operation and maintenance manuals.

E. Project record documents.

1. Record actual locations of valves.

F. Delivery, storage, and handling.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Grooved mechanical couplings and fasteners may be used in mechanical rooms.

C. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

D. Where connecting ferrous and non-ferrous piping materials, use full-port ball valves with bronze construction or a galvanized steel dielectric nipples with plastic liner to separate piping materials.

E. Use gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers or as shown on plans.

F. Use ball or butterfly valves for throttling, bypass, or manual flow control services or as shown on plans.

G. Use lug end butterfly valves to isolate equipment.

1.4 REGULATORY REQUIREMENTS

A. Conform to International Mechanical Code for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state and local labor regulations.

C. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.6 EXTRA MATERIALS

A. Provide two repacking kits for each size and valve type.

2. PRODUCTS

2.1 STEEL PIPING, FITTINGS, AND JOINTS

A. Applicable Systems

1. Heating water

B. Pipe: ASTM A53, Schedule 40, Grade B, black steel.

C. Fittings (2" and smaller): Malleable Iron: ASTM B16.3, Class 150, threaded or Cast Iron: ASTM B16.4, Class 125, threaded.

D. Fittings (2-1/2" and larger): ASTM B16.9, steel butt weld fittings.

E. Joints (2" and smaller): Threaded.

F. Joints (2-1/2" and larger): AWS D1.1, welded.

G. Unions (2" and smaller): 150 psig malleable iron, threaded.

H. Flanges (2-1/2" and larger): 150 psig forged steel, slip-on type.

1. Gaskets: Flexitallic Style CG semi-metallic spiral wound gaskets, no equivalent.

a. Filler material shall be Flexicarb (Graphite) SEL with max temperature rating of 842 deg F.
b. Gasket thickness:

1) 0.0625" for pipe sizes with maximum inside dimension up to 6".
2) 0.100" for pipe sizes with maximum inside dimensions between 6" and 10".

2. Flanges shall be flat face when mating with 125# class cast iron valves.

I. Grooved Mechanical Fittings:

1. Ductile Iron: ASTM A 536, Grade 65-45-12
2. Malleable Iron: ASTM A 47/A 47M, Grade 32510
3. Steel: ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
4. Standard of acceptance: Victaulic Style 107N Rigid Coupling.

J. Grooved Pipe End Couplings:

1. Housing Clamps: Malleable iron or ductile iron to engage and lock, designed to permit some angular deflection, contraction, and expansion.
2. Sealing Gasket: C-shape elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.

3. Accessories: Steel bolts, nuts, and washers.

2.2 COPPER TUBING, FITTINGS, AND JOINTS

A. Applicable Systems

1. Heating water
2. Equipment drains and overflows

B. Pipe: ASTM B88, Type L, hard drawn (2" and smaller)

C. Fittings and Unions (2" and smaller): ASME B16.22 wrought copper and bronze:

1. Solder filler metals: ASTM B32, lead-free alloys.
2. Flux: ASTM B813, water-flushable.
3. Copper Pressure-Seal-Joint Fittings
   a. Viega, Mueller or approved equivalent
   b. Fittings for pipes 2" and smaller: Wrought-copper fittings with EPDM-rubber, O-ring seal in each end.

D. Flanges (2-1/2" and larger): Bronze, 1/16 inch thick preformed neoprene gaskets.

E. STAINLESS STEEL PIPING, FITTINGS, AND JOINTS (PIPE SIZES LARGER THAN 2")

1. Applicable Systems

   a. Steam humidifier piping between boiler and dispersion grid.

2. Schedule 40 stainless steel pipe; same type stainless steel flanges and wrought stainless steel flanged fittings.
3. Schedule 40 stainless
4. Pipe to be slope per manufacturer's recommendations.
5. Provide drains per manufacturer's recommendations.

2.3 DIELECTRIC NIPPLE

A. Electroplated steel nipple, complying with ASTM F 1545 and IAPMO PS 66.

1. Rated for 300 psig at 225 deg F.
2. Male threaded or grooved end connections.
3. Inert and noncorrosive propylene lining.
4. Use a dielectric waterway equal to Victaulic or Clearflow

2.4 VALVES

A. CALIBRATED BALANCE VALVES

1. Pre-Set Balance Feature. Valves to be designed to allow Installing Contractor to pre-set balance points for proportional system balance prior to system start-up in accordance with scheduled flow rates.
2. Valve Design and Construction. All valves shall have a calibrated orifice or venturi section, two ¼" threaded pressure tap ports with integral seals, and memory stop to retain the set position. Valves should be rated for 125 psig working pressure and 250 Deg. F maximum operating temperature.
3. Valves shall be selected based on flowrate, not on pipe size dimensions.
4. Preformed Insulation. All valves to be provided with molded insulation to permit access for balance and read-out.
5. Bell and Gossett CBV, Tour & Andersson or Armstrong – Flow Setter ΔP type or equivalent

B. BALL VALVES

1. Up To and Including 2 Inches:

    a. Bronze two piece body, stainless steel full-port ball on all systems, Teflon seats and stuffing box ring, lever handle with balancing stops, solder or threaded ends. Include stem extensions on valves used in insulated piping systems. Victaulic 722, Nibco, or equal.
    b. Press connection with EPDM sealing element, brass / bronze, full port, non-potable application. Viega 2973, or equal.

C. BUTTERFLY VALVES

1. 2-1/2 Inches and Larger:

    a. Body: Cast or ductile iron with resilient replaceable EPDM seat, lug ends, extended neck.
    b. Disc: Aluminum bronze on closed systems and stainless steel on open systems.
    c. Stem: Stainless steel, extended on insulated systems as required to allow valve operation without damage to the insulation.
    d. Operator (4" and smaller): 10 position lever handle with memory stop, gear drive.
    e. Operator (6" and larger): Handwheel, gear drive.
    f. Chainwheel: On valves 6" and larger and installed higher than 8-feet above finished floor, provide sprocket rim, brackets, and chain compatible with valve.
    g. Grinnel or equal.

h. Grooved: Cast ductile iron, grooved ends, EPDM seat, off-set electroless-nickle fusion bonded DI disc, 300 PSI bubble tight dead-end service, 316SS stem, Victaulic Series 761 / W761 or equal.

D. SWING CHECK VALVES

1. Up To and Including 2 Inches:

a. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends. Nibco or equal.

2. Over 2 Inches:

a. Flanged, cast iron, 125 lb., bolted bonnet, horizontal swing, bronze trim. Nibco or equal.
b. Grooved, cast ductile iron, 300 PSI, horizontal or vertical swing, brass / SS trim. Victaulic Series 716 / W716 / 779 or equal.

E. SPRING LOADED CHECK VALVES

1. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

3. EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.2 INSTALLATION

A. Grooved pipe fittings and joints may only be used in accessible locations.

B. Where connecting ferrous and non-ferrous piping materials, use full-port ball valves with bronze construction or a galvanized steel dielectric nipples with plastic liner to separate piping materials.

C. Heating water connections to terminal units shall be copper (no steel).

D. Install all piping in accordance with ASME B31.9.

E. Route piping in orderly manner, parallel to building structure, and maintain gradient.

F. Install piping to conserve building space, and not interfere with use of space.

G. Group piping whenever practical at common elevations.

H. Sleeve pipe passing through partitions, walls and floors.

I. Slope piping and arrange to drain at low points.

J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

K. Refer to Section 23 05 29 and Section 23 05 48 for installation of supports and hangers.

L. Provide insulation clearance and access to valves and fittings in hangers and from structure and other equipment. Insulation shall be continuous through all hangers and supports. Refer to Section 23 07 19.

M. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with General Contractor and requirements of Section 23 05 00.

N. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

O. Install unions on both sides of each control valve and on one side of all other valves. Install unions on the equipment side of final connections to each piece of equipment. Unions are not required at flanged valves or equipment.

P. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

Q. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

R. Install valves with stems upright or horizontal, not inverted.

S. Provide insulated valve stem extensions on all valves installed in insulated piping systems.

T. Install chainwheel operators on valves 6" and larger that are installed 8-feet above finished floor or greater. Extend chain down to maximum 5-feet above finished floor.

U. Where possible, pipe connections shall be installed with the branch piping connected to the top of the main/header. If this is not possible due to space constraints, a connection with the same vertical centerline is acceptable. Connections to the bottom of the main/header is not allowed.

V. Provide solid chrome plated steel escutcheons cover the sleeves and openings at walls and ceilings in exposed areas.

3.3 SYSTEM FLUSHING, FILLING, PRESSURE TESTING AND CLEANING

A. Flush, fill, pressure test and clean all new hydronic systems and parts of existing systems which have been altered, extended or repaired.

B. Flush and fill systems with all valves open to coils. Bleed air from coils and piping. Clean strainers.

C. Pressure Test Procedure:

1. Reference Section 23 05 00 for minimum test pressures.
2. Submit copy of Pipe Pressure Test Log provided in section 23 05 00 for each section of piping tested. Refer to 23 05 00 for general pipe pressure testing requirements (i.e., test pressure gages, inspections, etc.).
3. Leave joints including welds uninsulated and exposed for examination during the test.
4. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
5. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
6. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
7. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test.
8. After the hydrostatic test pressure has been applied for at least 12 hours, examine piping,

joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

D. Clean systems.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 21 16
HYDRONIC SPECIALTIES

1. GENERAL

1.1 SECTION INCLUDES

A. Expansion tanks.

B. Air vents.

C. Air/Dirt separators.

D. Strainers.

E. Relief valves.

F. Flexible connections.

G. Chemical pot feeders.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

C. Project record documents

1. Record actual locations of hydronic specialties.

D. OPERATION AND MAINTENANCE DATA

1. Furnish service and maintenance of glycol system for one year from date of substantial completion.
2. Monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.
3. Provide full laboratory analysis of fluid at 6 months and 12 months from the date of substantial completion.

E. QUALIFICATIONS

F. DELIVERY, STORAGE AND HANDLING

2. PRODUCTS

2.1 EXPANSION TANKS

A. Construction: Welded steel, tested and stamped in accordance with ASME SEC VIII, Division 1; supplied with National Board Form U 1, rated for working pressure of 125 psig, with flexible, replaceable, butyl rubber bladder sealed into tank and steel support stand.

B. Accessories: Pressure gauge and air-charging fitting, tank drain.

2.2 AIR VENTS

A. Manual Type: Short vertical sections of equal diameter pipe, up to 2", to form air chamber, with ball valve, hose connection, and cap.

2.3 AIR/DIRT SEPARATORS

A. Air/Dirt Separators:

1. Steel construction, rated for 150 psig, and entering velocity not to exceed 10 feet per second at specified water flow rate.
2. Unit shall be capable of removing 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system.
3. Dirt separation shall be at least 80% of all particles 30 micron or larger within 100 passes.
4. Internal bundle filling the entire vessel consisting of a copper core tube with continuous wound copper medium permanently affixed to the core. A separate copper medium is to be wound completely around and permanently affixed to the internal element. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill. Separator shall have the vessel extended below the pipe connections an equal distance for dirt separation. Bottom connection for use as a blowdown.
5. Integral mounting lugs on large units (14" and larger) for use with contractor-provided mounting legs.
6. Unit shall be manufactured with internal magnet(s), if so noted on the drawings and schedule.

    a. Magnet(s) shall be positioned at the centerline of the inlet and outlet nozzles for maximum effectiveness during normal operation.

1) Units sized 2” through 6” shall have one magnet
2) Units with 8” though 12” shall have two magnets

b. Magnet(s) shall be removable from the vessel.
c. Magnet(s) shall be made of high-strength Neodymium alloy.
d. Magnet(s) shall be disengaged for dirt blowdown by means of a spring-loaded pull, without requiring removal of the magnet from the vessel or isolating the unit from the system.
e. Magnet option shall be provided with 360° rotatable blow down valve.

7. Manufacturer:

a. Heating Water: Spirotherm or approved equal

2.4 STRAINERS

A. Size 2 inch and Under:

1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch Type 304 stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch:

1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch Type 304 stainless steel perforated screen.

C. Size 5 inch and Larger:

1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch Type 304 stainless steel perforated screen.

D. Provide blowdown valves where shown on plan.

2.5 SAFETY RELIEF VALVES

A. Cast iron or Bronze body, EPDM seat, brass internal parts, automatic, direct pressure actuated, capacities ASME certified and labeled.

2.6 FLEXIBLE CONNECTIONS

A. Stainless steel braided connection with steel flange rated for 225 psig and 16" Hg vacuum. Operating temperature 20 degrees F. to 240 degrees F.

B. Minimum allowable movement shall be as follows:

Lateral Deflection	1/2"
Elongation	3/8"
Compression	1/2"
Angular Deflection	15 degrees

2.7 CHEMICAL POT FEEDERS

A. Manufacturer:

1. Neptune model DBF-5HP or equivalent.

B. Bypass feeder, vertical style, dish bottom out.

C. 4” high pressure fill cap rated to 300 psig, 2-1/2 turn design w/ coars thread.

D. Demountable leg extensions.

E. Filter bag kit.

3. EXECUTION

3.1 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions and as shown on drawings.

B. Provide manual air vents at all system high points and in accessible locations.

C. Provide drain valves at all low points and in accessible locations.

D. Provide heat trap piping arrangement for all expansion tanks as shown on drawings or per manufacturer instructions.

E. Provide appropriately sized structural supports for air/dirt separators. Support air/dirt separator independently of piping system for larger sizes per manufacturer’s instruction.

F. Provide valved drain and hose connection on strainer blow down connection.

G. Provide flexible connectors on pump suction and discharge.

H. Provide flexible connectors on all pipe connections that serve vibration isolated mechanical equipment.

I. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 21 23
HVAC Pumps

1. GENERAL

1.1 SECTION INCLUDES

A. Base-mounted, end-suction centrifugal pumps.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

1. HI - Hydraulic Institute.
2. ANSI - American National Standards Institute.
3. OSHA - Occupational Safety & Health Administration.
4. ASHRAE – American Society of Heating, Refrigeration and Air-Conditioning Engineers.
5. NEMA - National Electrical Manufacturers Association.
6. UL - Underwriters Laboratories.
7. ETL - Electrical Testing Laboratories.
8. CSA - Canadian Standards Association.
9. NEC - National Electric Codes.
10. ISO - International Standards Organization.
11. IEC - International Electrotechnical Commission.
12. ASME – American Society of Mechanical Engineers.

B. Performance requirements.

1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within ± 10 percent of scheduled performance and published operating curve.

C. Submittals.

1. Submit each item in this article according to the Conditions of the Contract and Division 1 Specification Sections.
2. Submit manufacturer's installation instructions under provisions of General Conditions and Division 1.

    a. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts lists.

b. Under provisions of commissioning documentation, testing of pumps, as well as training of owner's operation and maintenance personnel may be required in cooperation with the commissioning consultant.

3. Product Data including certified performance curves and rated capacities of selected model, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate pump's operating point on curves.
4. Complete Package information Product Data including:

   a. System summary sheet (where applicable)
   b. Sequence of Operation
   c. Shop drawing indicating dimensions, required clearances and location and size of each field connection
   d. Power and control wiring diagram
   e. System profile analysis including pump curves, system curve, and variable speed pump curves (where applicable)
   f. Pump data sheets - Rated capacities of selected models and indication of pump's operating point on curves.
   g. Submittals on furnished specialties and accessories
   h. Submittals must be specific to this project. Generic submittals will not be accepted

5. A detailed weighted average pump efficiency-Part Load Efficiency Value (PLEV) - Pump Rating Report shall be submitted for each pump. Pump PLEV shall be based on the standard load profile developed in AHRI 550/590-1998 also known as IPLV or Integrated Part Load Value. The pump PLEV Rating shall be expressed with load weighting pump PLEV=1/ (0.01/A+0.42/B+0.45/C+0.12/D) & shall be based points on A: 100%, B: 75%, C: 50% and D: 25%. Each Pump Efficiency ratings shown with flow matched to load percentage and Specified Control Head. Actual job specific load profile weighting may be substituted for standard IPLV weighting.
6. Pump and motor must meet minimum Department of Energy requirements and have a PEICL value less than 1
7. Specified Control Head shall be 30% TDH or calculated minimum control head specified within the equipment schedule
8. Hanging and supporting requirements should follow the recommendations in the manufacturer's installation instructions
9. Submittals that are "rejected" as being "non-compliant" will be re-reviewed once with all time for subsequent reviews back charged to the contractor in accordance with the engineer's current prevailing rate schedule. If a rate schedule for additional services is included, as part of the contract with the owner that rate schedule shall be used in lieu of the "current prevailing" rate schedule.

D. Quality Assurance

1. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified, or as denoted on the drawings.

2. Ensure pump operation at specified system fluid temperatures without vapor binding and cavitation, is non-overloading in parallel or individual operation, and operates to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.
3. Ensure pump pressure ratings are at least equal to system's maximum operating pressure at point where installed but not less than specified.
4. Equipment manufacturer shall be a company specializing in manufacture, assembly, and field performance of provided equipment with a minimum of 20 years experience.
5. Equipment provider shall be responsible for providing certified equipment start-up and, when noted, an in the field certified training session. New pump start-up shall be for the purpose of determining pump alignment, lubrication, voltage, and amperage readings. All proper electrical connections, pump's balance, discharge and suction gauge readings, and adjustment of head, if required. A copy of the start-up report shall be made and sent to both the contractor and to the Engineer.

E. Operation and maintenance data.

F. Qualifications.

G. Delivery, storage and handling.

1. Deliver materials to the site in such a matter as to protect the materials from shipping and handling damage. Provide materials on factory provided shipping skids and lifting lugs if required for handling. Materials damaged by the elements should be packaged in such a matter that they could withstand short-term exposure to the elements during transportation.
2. Store materials in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage.
3. Use all means necessary to protect equipment before, during, and after installation.
4. All scratched, dented, and otherwise damaged units shall be repaired or replaced as directed by the Architect Engineer.

H. Warranty

1. Provide a minimum One (1) year warranty on materials and installation under provision of Division 1.

I. Extra materials.

1. Provide one set of mechanical seals and gaskets for each pump.

2. PRODUCTS

2.1 BASE MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturer: Subject to compliance with requirements, provide comparable product by one of the following:

1. Bell and Gossett Series 1510
2. Armstrong Pumps, Inc.
3. Or approved equivalent.

B. See pump schedule on drawings for performance requirements.

1. The pumps shall be long coupled, base mounted, single stage, end suction, vertical split case design, in cast iron stainless steel fitted, specifically designed for quiet operation. Suitable standard operations at 225°F and 175 PSIG working pressure or optional operations at up to 250°F and 250 PSIG working pressures. Working pressures shall not be de-rated at temperatures up to 250F. The pump internals shall be capable of being services without disturbing piping connections, electrical motor connections or pump to motor alignment.
2. The pumps shall be composed of three separable components a motor, bearing assembly, and pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupling.
3. A bearing assembly shall support the shaft via two heavy-duty regreaseable ball bearings. Bearing assembly shall be replaceable without disturbing the system piping and shall have foot support at the coupling end. Pump bearings shall be regreaseable without removal of the bearings from the bearing assembly. Thermal expansion of the shaft toward the impeller shall be prevented via an inboard thrust bearing.
4. The bearing assembly shall have a solid SAE1144 steel shaft. A stainless steel shaft sleeve shall be employed to completely cover the wetted area under the seal.
5. Pump shall be equipped with an internally-flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Application of an internally flushed mechanical seal shall be adequate for seal flushing without requiring external flushing lines. Seal assembly shall have Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
6. Bearing assembly shaft shall connect to a stainless steel impeller. Impeller shall be both hydraulically and dynamically balanced to ANSI/HI 9.6.4-2016, balance grade G6.3 and secured by a stainless steel locking cap screw or nut.
7. Pump should be designed to allow for true back pull-out allowing access to the pump's working components, without disturbing motor or piping, for ease of maintenance.
8. A center drop-out type coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed application shall be provided with a suitable coupling sleeve. Coupling shall allow for removal of pump's wetted end without disturbing pump volute or movement of the pump's motor and electrical connections. On variable speed applications the coupling sleeve should be constructed of an neoprene material to maximize performance life.
9. An ANSI and OSHA rated coupling guard shall shield the coupling during operation. Coupling guard shall be dual rated ANSI B15.1 and OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling. No more than .25 inches of either rotating assembly shall be visible beyond the coupling guard.

10. Pump volute shall be of a cast iron design for heating systems with integrally cast pedestal volute support, rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. (Optional 250 PSIG working pressures are available and are 250# flange drilled.) Volute shall include gauge ports at nozzles, and vent and drain ports.
11. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Pump and motors shall be factory aligned, and shall be realigned after installation by the manufacturer's representative. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications and conform to standards outlined in EISA 2007.
12. Base plate shall be of structural steel or fabricated steel channel configuration fully enclosed at sides and ends, with securely welded cross members and fully open grouting area (for field grouting). The minimum base plate stiffness shall conform to ANSI/HI 1.3.8.2.1-2019 for grouted Horizontal Baseplate Design standards.
13. Pump shall be of a maintainable design and, for ease of maintenance, should use machine fit parts and not press fit components.
14. The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 9.6.4-2016 for recommended acceptable unfiltered field vibration limits (as measured per ANSI/HI 9.6.4-2016 Figure 9.6.4.2.3.1) for pumps with rolling contact bearings.
15. Pump manufacturer shall be ISO-9001 certified.
16. Each pump shall be hydrostatically tested 1.5 times the maximum rated working pressure and name-plated before shipment.
17. Pump shall conform to ANSI/HI 9.6.3.1-2012 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.

C. Accessories:

1. Provide one mechanical seal for each model type of primary pump based on scheduled operating temperature.
2. Prov with internal volute wear rings, galvanized drip pan, or special spacer couplings.
3. Where noted on schedule a stuffing box design may be used in lieu of the traditional internally flushed mechanical seal design. Pump shall be flushed single seal or packing gland type seal arrangements.

2.2 PUMP SPECIALTY FITTINGS

A. Suction Diffuser

1. Manufacturer: Subject to compliance with requirements, provide comparable product by one of the following:

   a. ITT Corporation
   b. Taco Comfort Solutions, Inc.
   c. Armstrong Pumps, Inc.
   d. Grundfos Pumps Corporation
   e. Or equivalent.

2. Angle pattern.
3. 175 psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
4. Cylinder stainless steel strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.
7. Blowdown tap
8. Gage tap

3. EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. All components shall be installed in accordance with manufacturer's installation instructions.

B. Reduction from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow.

C. Furnish and install check valve, isolation valve and balance valve on the discharge side of all pumps and furnish and install a line size shut-off valve on the suction side of all pumps. Furnish and installed suction diffuser on the inlet side of a pump to provide appropriate flow distribution into the eye of the pump's impeller.

D. Provide temperature and pressure gauges where and as detailed or directed.

E. Proper access space around a device should be left for servicing the component. No less than the minimum recommended by the manufacturer.

F. Provide an adequate number of isolation valves for service and maintenance of the system and its components.

G. Circulating pump shall have sufficient capacity to circulate the scheduled GPM against the scheduled external head (feet) with the horsepower and speed as scheduled and/or as denoted on the drawings. Motors shall be of electrical characteristics as scheduled, denoted and/or as indicated on the electrical plans and specifications. Pump characteristics shall be such that the head of the pump under varying conditions shall not exceed the rated horsepower of the drive motor.

H. On systems where the final balancing procedure requires the balancing valve to be throttled more than 25% to attain design flow (on a constant speed pumping system), and no future capacity has been built into the pump, the pump impeller must be trimmed to represent actual system head resistance. The pump provider and engineer of record, based on the balancing contractor's reports, shall determine the final impeller trim diameter.

I. Install foot mounted and base mounted pumps on vibration isolation pad and house keeping pad, via anchor bolts. Set and level and grout in place.

J. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.

K. On components that require draining, contractor must provide piping to and discharging into appropriate drains.

L. Provide drains for bases and seals, piped to and discharging into floor drains.

M. Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer's instruction and applicable state, federal, and local codes.

N. Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the control's contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal, and local codes.

3.3 START-UP AND COMMISSIONING

A. Start-up pump in accordance to manufacturer written instructions.

B. Before and after start-up, perform the following preventative maintenance operations and checks:

1. Lubricate bearings.
2. Check, align and certify alignment of base mounted pumps prior to start-up. Pump alignment shall be certified by 3rd party testing agency using laser alignment procedures.
3. After pump is started, check for proper rotation, proper mechanical operation and motor load to ensure that pump is not overloaded. Close pump balancing valve as required to bring pump motor load within motor nameplate data.
4. Check pumps to ensure it is not air bound or cavitating.
5. After sufficient run time, remove, check and clean strainer as required. Repeat cleaning strainer until system is sufficiently flushed. Refer to Section 23 25 00, Chemical Water Treatment.
6. After completing start-up, replace pump strainer with permanent strainer.

C. Coordinate pump testing, adjusting and balancing with Balancing Contractor. Complete additional preliminary work required by Balancing Contractor.

END OF SECTION

SECTION 23 31 13
DUCTWORK

1. GENERAL

1.1 SECTION INCLUDES

A. Metal ductwork.

1. Sheet metal materials.
2. Sealant and gaskets.
3. Fasteners.
4. Seismic-restraint devices.
5. Duct cleaning.
6. Duct pressure testing.

B. Insulated flexible ductwork.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Perform Work in accordance with the following standards:

a. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
b. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
c. SMACNA - HVAC Air Duct Leakage Test Manual.
d. SMACNA – HVAC Duct Construction Standards - Metal and Flexible.
e. SMACNA - Round Industrial Duct Construction Standards
f. International Mechanical Code, current edition.

B. References.

C. Submittals.

1. Submit detailed CAD-generated ductwork detail drawings at minimum ¼" scale, with details of the following:

a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
b. Duct layout indicating pressure classification and sizes on plans.
c. Seam and joint construction.
d. Penetrations through fire-rated and other partitions.

e. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

NOTE: No installation of ductwork shall be allowed until detailed shop drawings have been reviewed by the Engineer. Any ductwork that is installed prior to the Engineer's review of the shop drawings shall be subject to removal and replacement at the Contractor's expense.

D. Performance requirements.

1. No variation of duct configuration or sizes shall be permitted except by written permission.
2. Structural Performance: Duct hangers, supports, and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." Reference Structural Design Criteria on General Structural Note Sheet in Structural Drawings for seismic hazard level classification.

a. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
b. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
c. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

E. Project record documents.

1. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.
2. Provide copy of owner approval/acceptance of ductwork cleaning.
3. Provide copy of completed duct leakage test reports.

F. Qualifications.

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
2. Installer: Company specializing in performing the work of this section with minimum five years experience.

G. Regulatory requirements.

1. Construct all ductwork per codes listed in section 1.2.E

H. Environmental requirements.

1. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

2. Maintain temperatures during and after installation of duct sealants.

2. PRODUCTS

2.1 METAL DUCTWORK

A. SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

1. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

    a. Reference SMACNA figure 2-9 and Drawings to construct gradual transitions where ductwork changes size or offsets.
    b. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

2. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Transverse Duct Connection System

        1) Slide on flange system: Ductmate and Ductmate WDCI connection system complete with interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips. Gasket material shall be chemical resistant material in all fume exhaust ductwork.
        2) Formed on flange system: TDC, TDF or equivalent connection system or equivalent. Such flanges shall be constructed as SMACNA T-24 flange (Page 1-25 and 1-37 '85 SMACNA Duct Construction Manual, 1985 Edition).

3. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
4. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Construct T's, and elbows in using radius of not less than 1-1/2 times width of duct on centerline. Where mitered rectangular elbows are used or indicated, provide turning vanes in accordance with Section 23 33 00.

5. Welded ductwork is to be weld with filler rod of the same material as the metal that is being welded. Coat welded joints with protective paint to prevent damage to galvanized surfaces.

B. SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

1. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

a. Round and oval duct shall be spiral lockseam duct with light reinforcing corrugations unless indicated otherwise.

2. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
3. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
b. Joints shall be minimum 2 inch insertion length for joint connections.
c. Transverse Duct Connection System

1) Slip type connector: Keating coupler.
2) Slide on flange system. Spiralmate and Ovalmate connection system complete with interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips. Gasket material shall be chemical resistant material in all fume exhaust ductwork.
3) Formed on flange system: Factory-applied Van Stone connection on one end of the duct with field-applied Van Stone connecter on the other end of the duct. Provide factory-applied Van Stone connections on each end of fittings.

4. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

5. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Construct T's, bends, and elbows with minimum bend radius elbows shall be 1.5 times the duct diameter (major or minor axis on oval ductwork depending on direction of bend). Where not possible and where mitered elbows are used or indicated, provide turning vanes in accordance with Section 23 33 00.

6. Welded ductwork is to be weld with filler rod of the same material as the metal that is being welded. Coat welded joints with protective paint to prevent damage to galvanized surfaces.
7. On round and oval ducts, provide 45 deg wye tee take-offs or 90 deg conical tee take-offs or 45 degree low loss entry tee take-offs or other fitting as indicated on plans. Straight taps are not acceptable.

C. SHEET METAL MATERIALS

1. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
2. Galvanized Steel Ducts: ASTM A653 galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90. Provide mill-phosphatized finish for surfaces of ducts exposed to view.
3. Stainless Steel Ducts: ASTM A 480/A 480M, Type 316 sheet form with No. 4 finish for surfaces of ducts exposed to view, and Type 304 sheet form with No. 1 finish for
4. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
5. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

D. SEALANT AND GASKETS

1. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
2. Two-Part Tape Sealing System:

a. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
b. Tape Width: Min. 3 inches.
c. Sealant: Modified styrene acrylic.
d. Water resistant.
e. Mold and mildew resistant.
f. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
g. Service: Indoor and outdoor.
h. Service Temperature: Minus 40 to plus 200 deg F.
i. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
j. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Water-Based Joint and Seam Sealant:

a. Application Method: Brush on.
b. Solids Content: Minimum 65 percent.
c. Shore A Hardness: Minimum 20.
d. Water resistant.
e. Mold and mildew resistant.
f. VOC: Maximum 75 g/L (less water).
g. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
h. Service: Indoor or outdoor.
i. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

4. Flanged Joint Sealant: Comply with ASTM C 920.

a. General: Single-component, acid-curing, silicone, elastomeric.
b. Type: S.
c. Grade: NS.
d. Class: 25.
e. Use: O.
f. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

5. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
6. Round Duct Joint O-Ring Seals:

a. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
b. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

c. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

E. FASTENERS

1. Rivets, bolts, or sheet metal screws.

2.2 INSULATED FLEXIBLE DUCTS

A. UL 181, Class 1, mechanically-locked spun nylon fabric supported by helically wound spring steel wire; fiberglass insulation; fire retardant polyethylene vapor barrier film.

B. Pressure Rating: 6 inches WG positive, 5.0 inches WG negative (through 16" diameter), 1.0' WG negative (18" to 20").

C. Maximum Velocity: 5500 fpm.

D. Temperature Range: -20 degrees F to 250 degrees F.

E. Minimum Sound Attenuation Performance (Insertion Loss in dB of 12' Length of 12" Round Duct):

1. 63 Hz Octave Band: 13
2. 125 Hz Octave Band: 37
3. 250 Hz Octave Band: 31
4. 500 Hz Octave Band: 34
5. 1 kHz Octave Band: 37
6. 2 kHz Octave Band: 47
7. 4 kHz Octave Band: 34

F. Manufacturer: Flexmaster Type 6B or equivalent.

3. EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions; SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition and International Mechanical Code requirements.

B. Seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition.

C. Duct sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.

D. Duct transition from round to rectangular and vise versa shall be made with rectangular to round duct transition fitting.

E. Provide flange-type joint at transverse joints or seal as specified. All transverse joints shall be inspected by the Owner prior to insulating ductwork.

3.2 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install round and flat-oval ducts in maximum practical lengths.

a. Install round in lengths not less than 12 feet, unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

H. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

I. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

1. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Keep openings covered until ready for continuing duct run or final connections.

J. Construct and install each duct system for the specific duct pressure classification indicated.

K. Install only low loss high efficiency fittings at takeoffs. Extractors not allowed.

1. Air terminal take-offs from rectangular main ducts shall be lo-loss 45°F take-offs.
2. Diffusers and register take-offs from rectangular duct mains shall be lo-loss 45° fittings, with integral balancing damper that is provided with stand-off bracket and quadrant lock.
3. Exhaust grille/register branch duct connections to rectangular mains shall be lo-loss 45° entry fittings with integral balancing damper.

L. Install couplings tight to duct wall surface with a minimum of projections into duct.

M. Install ducts with a clearance of 2 inch, plus allowance for insulation thickness.

N. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

O. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire damper, sleeve, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 07 Section "Firestopping."

1. Refer to drawings for more information.

P. Verify location of air outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Refer to reflected ceiling plans, finish schedule, material finish specification, and shop drawings.

Q. Coordinate routing with all other trades to establish space requirements for each.

R. Contractor may vary route and shape of ductwork and make offsets during progress of work if required to meet structural or other interferences. Where such changes impair the system performance, the changes will be corrected at Contractor's expense.

S. All ductwork shall be substantially and neatly supported on galvanized steel straps or angles riveted or bolted to duct flanges and properly anchored to the construction so that horizontal ducts are without sag or sway, vertical ducts are without buckle, and all ducts are free from the possibility of deformation, collapse or vibration. Support at each joint and at 4 feet on center maximum.

T. Openings required for ductwork through structural elements in new construction shall be coordinated with the General Contractor. Shop drawings locating such openings shall be prepared in ample time to meet the construction schedule.

U. Provide sleeves at all duct penetrations through walls, floors and roofs. Openings through sound-rated partitions shall have annular space stuffed with fiberglass insulation for full thickness of wall.

V. Provide 2-inch deep bitumastic coated drip pans on all non-ducted hoods, fans or penthouses used for relief or exhaust air service. Pans shall be 12 inches larger all around than roof opening with clear vertical openings between pan and structure as indicated. Insulate pan where indicated.

W. Where required on drawings, install automatic control dampers as recommended by the manufacturer.

X. Prevent passage of unfiltered air around filters with felt, rubber, neoprene gaskets, or other approved safing material.

Y. Provide openings in ductwork to accommodate thermometers and controllers. Provide pitot tube openings for testing of systems, complete with metal cap with spring device or screw to prevent air leakage.

Z. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

AA. Paint ductwork visible behind wall-mounted air outlets and inlets matte black.

1. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

BB. Change duct sizes gradually, not exceeding 30 degrees (15 degrees ideally) divergence and 45 degrees (30 degrees ideally) convergence.

CC. Use crimp joints with or without bead for joining round duct sizes 8 inches and smaller and install with crimp in direction of air flow.

DD. Provide return air grilles open to ceiling plenum with duct boot with minimum longitudinal dimension 2′ X 2′.

EE. Provide flexible connect between ductwork and all moving equipment.

1. Provide 1-inch slack for free movement.

FF. Join VAV boxes to medium pressure supply duct mains with minimum straight length of duct equal to 5 times box inlet diameter size. Duct to be rigid. Flexible ductwork is not allowed to join boxes to supply duct main.

GG. Threaded cap test holes shall be provided in all ductwork. Test holes shall be installed after the reheat coil in all VAV boxes. Provide extensions to allow for insulation thickness. Test holes shall be "Ventlok" or equal.

HH. Connect flexible ducts to metal ducts with stainless steel bands with worm gear tightener, nylon bands are unacceptable.

II. Unless otherwise noted, provide maximum of 6' of flexible duct upstream of each diffuser or grille. See details on Drawings.

JJ. Flexible ductwork shall not be used on ducted return or exhaust systems.

KK. Cover all exposed fiberglass insulation with duct tape.

3.3 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

F. Exposed ductwork serving ventilated workstations and corrosive storage cabinets:

1. Install the exposed stainless steel ductwork serving the ventilated workstations with the longitudinal weld facing the adjacent wall and away from public view. If possible, install one continuous exposed duct without transverse joints. Install escutcheon ring at ceiling penetration. Ring shall be same material and same finish as exposed duct. Note that exposed ductwork shall be provided with a No. 4 finish. Verify acceptable appearance of installed ductwork with Architect after installation.

G. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.

H. Provide closure flanges around exposed ductwork at wall and ceiling penetrations, 1-1/4 inches wide minimum.

3.4 INSTALLATION OF CLOTHES DRYER DUCTWORK

A. Installation. Clothes dryers shall be exhausted in accordance with the manufacturer's instructions. Dryer exhaust systems shall be independent of all other systems and shall convey the moisture and any products of combustion to the outside of the building.

B. Exhaust penetrations. Ducts that exhaust clothes dryers shall not penetrate or be located within any fireblocking, draftstopping or any wall, floor/ceiling or other assembly required by the International Building Code to be fire-resistance rated, unless such duct is constructed of galvanized steel or aluminum of the thickness specified in Section 603.3 and the fire-resistance rating is maintained in accordance with the International Building Code.

C. Cleanout. Each vertical riser shall be provided with a means for cleanout.

D. Exhaust installation. Dryer exhaust ducts for clothes dryers shall terminate on the outside of the building and shall be equipped with a backdraft damper. Screens shall not be installed at the duct termination. Ducts shall not be connected or installed with sheet metal screws or other fasteners that will be obstruct the exhaust flow. Clothes dryer exhaust ducts shall not be connected to a vent connector, vent or chimney. Clothes dryer exhaust ducts shall not extend into or through ducts or plenums.

E. Domestic clothes dryer ducts. Exhaust ducts for domestic clothes dryers shall be constructed of metal and shall have a smooth interior finish. The exhaust duct shall be a minimum nominal size of 4 inches (102mm) in diameter. The entire exhaust system shall be supported and secured in place. The male end of the duct at overlapped duct joints shall extend in the direction of airflow. Clothes dryer transition ducts used to connect the appliance to the exhaust duct system shall be limited to single lengths not to exceed 8 feet (2438 mm) and shall be listed and labeled for the application. Transition ducts shall not be concealed within construction.

F. Provide with chimney cap and backdraft damper.

3.5 INSTALLATION OF 2" AND GREATER PRESSURE CLASS DUCTWORK (POSITIVE OR NEGATIVE PRESSURE)

A. All round and oval duct elbows installed shall be die-formed, gored, pleated or mitered. All mitered elbows shall be equipped with turning vanes.

B. On round and oval ducts, provide 45 deg wye or 90 deg conical tee take-offs as indicated on plans. Straight taps are not acceptable.

C. All diverging flow fittings shall be constructed such that no excess material projects from the body into the branch tap entrance.

D. Transverse joints of all rectangular ducts greater than 24" wide or deep shall be fabricated with flanging system as called out previously (Ductmate or equivalent).

3.6 CLEANING

A. **The air handling units, energy recovery wheel, exhaust fans, and other HVAC airside equipment shall not be used for temporary building conditioning without the written permission from the Owner and Architect/Engineer.** Open ductwork that has been installed shall be protected during the duration of the project with polyethylene plastic and duct tape over the open ends. Uninstalled ductwork shall be protected from construction dust by covering the uninstalled ductwork with polyethylene plastic. Prior to installing ductwork, the inside of the ductwork shall be wiped down or vacuumed.

B. Clean inside all air handling units, energy recovery units, and outside air duct systems before the fans are turned on. Call for inspection by the owner's representative to verify that all ducts are cleaned. If the ductwork is unacceptable, the contractor shall provide vacuuming of these duct systems by forcing air at high velocity through duct where manual cleaning in not possible due to duct lengths or size. Call for re-inspection by Owner's representative.

C. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

D. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

E. Use service openings, as required, for physical and mechanical entry and for inspection.

F. Call for inspection by Owner's representative and provide documentation of owner approval to engineer and include copy in maintenance manuals.

G. Install a fresh set of filters in all equipment immediately prior to project turnover.

3.7 DUCTWORK SCHEDULE

Supply Air

Duct System:	Material:	Longitudinal Joints:	Transverse Joints:	Pressure Class:	Sealant Class:	Leakage Class:	Additional Notes:

Duct System:	Material:	Longitudinal Joints:	Transverse Joints:	Pressure Class:	Sealant Class:	Leakage Class:	Additional Notes:
Rectangular SA system upstream of terminal units	Galv. Steel	3A, 3E	4A, 4C, 4D	+6”	A	6	8B
Round SA system upstream of terminal units	Galv. Steel	3C, 3E	4B, 4D	+6”	A	3	8B, 8C
Rectangular SA system downstream of terminal units	Galv. Steel	3A, 3B, 3E	4A, 4C, 4D	+2”	A	24	8B
Round SA system downstream of terminal units	Galv. Steel	3C, 3E	4B, 4D	+2”	A	12	8B, 8C

Exhaust Air

Duct System:	Material:	Longitudinal Joints:	Transverse Joints:	Pressure Class:	Sealant Class:	Leakage Class:	Additional Notes:
Rectangular EA system downstream of terminal unit	Galv. Steel	3A, 3E	4A, 4C, 4D	-6”	A	6	8B
Round EA system downstream of terminal unit	Galv. Steel	3C, 3E	4B, 4D	-6”	A	3	8B, 8C
Rectangular EA system upstream of terminal unit	Galv. Steel	3E	4A	-2”	A	24	8B, 8C
Round EA system upstream of terminal unit	Galv. Steel	3C	4B	-2”	A	12	8B, 8C

Dedicated Biosafety Cabinet Exhaust Air Systems

Duct System:	Material:	Longitudinal Joints:	Transverse Joints:	Pressure Class:	Sealant Class:	Leakage Class:	Additional Notes:
Rectangular EA system between exhaust fan and BSC	Stainless Steel	3E	4D	-6”	A	6	8A, 8B
Round EA system between exhaust fan and BSC	Stainless Steel	3E	4D	-6”	A	3	8A, 8B, 8C

DUCTWORK SCHEDULE NOTES:

Longitudinal Joint Options:
3A: Pittsburgh lock. Refer to Figure 1-5, SMACNA.
3B: Button punch snap lock. Refer to Figure 1-5, SMACNA.
3C: Spiral lockseam.

3E: Welded.
3F: Double-wall, pre-manufactured sheet metal plenum.
3G: Butt-welded, fully-welded around entire perimeter of joint from outside in accordance with IMC.

Transverse Joint Options:
4A: Pre-manufactured flanged duct connection system specified under "Products" section of this specification.
4B 0-24" Major Axis Diameter: Interior slip coupling beaded at center, fastened to duct with sealing compound applied continuously around joint before assembling and after fastening.
26" Major Axis Diameter and Up: Pre-manufactured flanged duct connection system specified under "Products" section of this specification.
4C: Any standard transverse joint as shown in Figure 1-4 of SMACNA is acceptable.
4D: Welded
4E: Fully-welded at all joints from outside in accordance with IMC.

Sealant Class Options:
6: Seal class is defined by the following table (refer to Table 4-1, SMACNA HVAC Air Duct Leakage Test Manual):

Seal Class:	Sealing Required:
A	All transverse joints, longitudinal seams, and ductwork penetrations. Pressure sensitive tape shall not be used as a primary sealant on metal ducts.
B	All transverse and longitudinal seams. Pressure sensitive tape shall not be used as a primary sealant on metal ducts.
C	Transverse joints only.

Leakage:
7: Leakage Class is defined by Figure 4-1, SMACNA HVAC Air Duct Leakage Test Manual.

Additional Comments:
8A: See Drawings for further information regarding extent of stainless steel ductwork.
8B: Field welded ductwork is to be welded with filler rod of the same material as the metal that is being welded. Field coat welded joints with protective paint to prevent damage to galvanized surfaces.
8C: **Regardless if allowable by SMACNA, Snaplock longitudinal joints shall not be used for round ductwork.**

3.8 PRESSURE TESTING

A. Perform and complete the following field tests, inspections, and test reports according to SMACNA's "HVAC Air Duct Leakage Test Manual":

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
3. Maximum Allowable Leakage: Refer to paragraph 3.7.
4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.
5. Test no less than

    a. 100% of the ductwork

6. Submit completed test reports to engineer and include copy in maintenance manual.

END OF SECTION

SECTION 23 33 00
DUCTWORK ACCESSORIES

1. GENERAL

1.1 SECTION INCLUDES

A. Turning vanes.

B. Duct access doors.

C. Duct test holes.

D. Flexible duct connections.

E. Manual balancing dampers.

F. Gravity backdraft dampers.

G. Remote damper operators

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

C. Project record documents.

1. Record actual locations of access doors, test holes etc.

D. Qualifications.

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

E. Regulatory requirements.

1. Products Requiring Electrical Connection: UL Listed and classified.

F. Delivery, storage, and handling.

G. Extra materials.

1. Provide two of each size and type of fusible link for fire and combination fire/smoke dampers.

2. PRODUCTS

2.1 TURNING VANES

A. General:

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
2. Note that air extractors or "scoops" shall not be used under any circumstances.

B. Manufactured and Fabricated Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
2. Single-Thickness Vane Construction: Vanes shall be single-thickness, quarter-circle shape with 2” radius, minimum 3.15” length, and spaced 1.5” on center.
3. Double-Thickness Vane Construction: Vanes shall be double-thickness, quarter-circle shape, with 4.5” radius and spaced 3.25” on center.

2.2 DUCT ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Double wall, rectangular door.
2. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
3. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.

    a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
    c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
    d. Access Doors Larger Than 24 by 48 Inches : Four hinges and two compression latches with outside and inside handles.
    e. Fabricate doors airtight and suitable for duct pressure class.

4. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

2.3 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.4 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches to 5-3/4 inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.

1. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

   a. Minimum Weight: 26 oz./sq. yd.
   b. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   c. Service Temperature: Minus 40 to plus 200 deg F.

2. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

   a. Minimum Weight: 24 oz./sq. yd.
   b. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   c. Service Temperature: Minus 50 to plus 250 deg F.

3. Fume Exhaust System, Flexible Connectors: Glass fabric with chemical-resistant coating.

   a. Minimum Weight: 14 oz./sq. yd.
   b. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
   c. Service Temperature: Minus 67 to plus 500 deg F.

4. Fan Discharge Flexible Connectors: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

    a. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
    b. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
    e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
    f. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
    g. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.5 MANUAL BALANCING DAMPERS

A. General:

1. Suitable for horizontal or vertical applications.
2. Fabricated in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
3. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
4. **Provide 304 stainless steel construction when installed in stainless steel duct systems.**

B. Single Blade Dampers:

1. Ruskin models MD25 (rectangular), MDRS25 (round) or equivalent.
2. Fabricate for duct sizes up to 6 x 30 inch.
3. Frame: 20 gauge galvanized steel, 6” wide.
4. Blade: 20 gauge galvanized steel.
5. Control shaft / hand quadrant: 3/8” square axle shaft extending beyond frame through factory mounted, locking hand quandrant.

    a. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Regulator shall be equivalent to Sheet Metal Connectors Model RP-3, with heavy-gauge steel regulator, wing nut locking assembly, and stamped dial indicating damper position.
    b. On externally insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters to avoid damaging or compression of insulation.

6. Bearings: Molded synthetic.
7. Finish: Mill galvanized.
8. Maximum velocity: 1500 fpm.
9. Maximum temperature: 250 deg F.

C. Multi-Blade Damper:

1. Ruskin model MD35 or equivalent.
2. Frame: 5" x 1" x 16 gauge galvanized steel channel with corner braces. Low profile top and bottom 3-1/2" x 3/8" x 16 gauge galvanized steel channel 13" high and under, actual.
3. Blade: 8" maximum width 16 gauge galvanized steel, opposed blade.
4. Blade stop: 20 gauge galvanized steel.
5. Finish: Mill galvanized.
6. Linkage: Exposed or concealed as recommended by manufacturer.
7. Axles: ½" hex.
8. Bearings: Molded synthetic.
9. Control shaft: 3" x 3/8" square plated steel, ½" dia. Jackshaft for multisection dampers.
    a. Jackshaft to operate multi-section damper from one side.
10. Temperature limits: -40 deg F min. to 240 deg F max.
11. Quadrants:
    a. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Regulator shall be equivalent to Sheet Metal Connectors Model RP-3, with heavy-gauge steel regulator, wing nut locking assembly, and stamped dial indicating damper position.
    b. On externally insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters to avoid damaging or compression of insulation.
    c. Where rod lengths exceed 30 inches, provide regulator at both ends.

2.6 TAKEOFFS

A. Manufactured high-efficiency takeoff with 45-degree slope on the body, with gauge thickness equal to adjacent ductwork.

1. Damper may be provided with high-efficiency takeoff pending conformance with product requirements for manual balancing dampers.

2.7 GRAVITY BACKDRAFT DAMPERS

A. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 16 gage thick extruded aluminum, with blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

B. Accessories

1. Flange Frame: 1-1/2 inches (38 mm), roll formed as part of frame.
2. Factory Sleeve: Aluminum. Minimum 0.080 inch (2.032 mm) thickness, minimum 8 inches (203 mm) length.
3. Bird or Insect Screen: Front or rear mounted to damper with mounting sleeve.

    a. Bird Screen: ½" x ½" x 0.063" woven aluminum intercrimped mesh.

4. Duct Transition Connection: Rectangular.

2.8 CABLE REMOTE DAMPER OPERATORS

A. Manufacturer: Metropolitan Air Technology or approved equivalent, model RT-250 (Round) and RT-200 (Rectangular).

B. RT-250:

1. Furnish cable operated remote controlled volume dampers in ducts located in inaccessible ceilings and where otherwise indicated. Reference architectural drawings for locations of gypsum board, spline etc. ceilings and other inaccessible damper locations. Damper frame (sleeve) construction shall be 20 gage (.91mm) roll formed, galvanized steel with beads at each end. Blades shall be 20 gage (.91mm) round single piece design, mechanically attached to the axle with support brackets. Axles shall be 3/8" (9.52mm) square plated steel with molded synthetic bearings housed in the damper frame. Damper control shaft shall be 3/8" (9.52mm) square shaft, minimum of 3" (75mm) long. Dampers shall be adjusted via a universal worm gear drive that is actuated by an unsheathed rotary cable which is captured at the damper end by a shaft coupling integral to the worm gear assembly. The rotary cable shall be terminated at the ceiling line or in a wall opening and concealed inside a ceiling/wall cup (RT-CCS, or RT-CCM) that is secured to the ceiling (or wall) framing. The cups shall provide a secure, unobtrusive appearance flush with the finished wall or ceiling. The universal damper drive shall be furnished as a complete assembly with universal mounting capabilities to accommodate damper shaft sizes from ¼"-3/8" square (6m – 9.5mm), or ¼"-1/2" (6mm- 12.7mm) round. The drive unit construction shall consist of a 14 gage galvanized mounting bracket, an aluminum worm and gear, and a black oxide coated steel drive shaft/cable coupling. Cable support clamps shall be factory furnished as required by the cable length. Ceiling Cup, rotary cable, and worm gear (damper drive system) shall be furnished as one piece for installation in the field with no linkage adjustment required or miscellaneous small parts. Direct, two-way damper control shall be provided without sleeves, springs, or screw adjustments (that may loosen after ceiling closure). Cable operated dampers shall be furnished with RT-WGA worm gear assembly and RT-CCM, or RT-CCS Ceiling Cups.BO-100 Construction:

C. RT-200:

1. Furnish cable operated remote controlled volume dampers in ducts located in inaccessible ceilings and where otherwise indicated. Reference architectural drawings for locations of gypsum board, spline etc. ceilings and other inaccessible damper locations. Damper frame (sleeve) construction shall be 16 gage (1.6 mm) galvanized steel channel frame. Blades shall be 16 gage (1.6 mm) galvanized steel V formed construction, mechanically attached to the axle with support brackets. Axles shall be 3/8" (9.52mm) square plated steel with molded synthetic bearings housed in the damper frame. Damper control shaft shall be 3/8" (9.52mm) square shaft, minimum of 3" (75mm) long. Dampers shall be adjusted via a universal worm gear drive that is actuated by an unsheathed rotary cable which is captured at the damper end by a shaft coupling integral to the worm gear assembly. The rotary cable shall be terminated at the ceiling line or in a wall opening and concealed inside a ceiling/wall cup (RT-CCS or RT-CCM) that is secured to the ceiling (or wall) framing. The cups shall provide a secure, unobtrusive appearance flush with the finished wall or ceiling. The universal damper drive shall be furnished as a complete assembly with universal mounting capabilities to accommodate damper shaft sizes from ¼"-3/8" square (6m – 9.5mm), or ¼"-1/2" (6mm- 12.7mm) round. The drive unit construction shall consist of a 14 gage galvanized mounting bracket, an aluminum worm and gear, and a black oxide coated steel drive shaft/ cable coupling. Cable support clamps shall be factory furnished as required by the cable length. Ceiling Cup, rotary cable, and worm gear (damper drive system) shall be furnished as one piece for installation in the field with no linkage adjustment required or miscellaneous small parts. Direct, two-way damper control shall be provided without sleeves, springs, or screw adjustments (that may loosen after ceiling closure). Cable operated dampers shall be furnished with RT-WGA worm gear assembly and RT-CCM or RT-CCS Ceiling Cups.

3. EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 13 for duct construction and pressure class.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts and stainless-steel accessories in stainless-steel ducts.

C. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. Upstream or downstream from duct silencers.
8. Control devices requiring inspection.
9. Elsewhere as indicated.

D. Unless duct access door size is explicitly indicated, provide minimum 24 x 18 inch size duct access doors wherever possible. Provide 18 x 18, 12 x 12 inch or 8 x 8 inch size elsewhere, using the largest size possible.

E. Install access doors with swing against duct static pressure.

F. Provide duct test holes where indicated and required for testing and balancing purposes. Install with minimum 24” clear dimension from any side wall or other obstruction.

G. Provide fire dampers, combination fire and smoke dampers and smoke dampers at locations indicated and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

H. Coordinate installation of all fire dampers, combination fire and smoke dampers, and smoke dampers with all other disciplines to ensure a minimum of 24 x 24 inch clear horizontal access area from the ceiling vertically to the damper. The clear access area will be used for the inspection of damper fusible links and damper operators, as well as for the resetting of damper. Clear access areas and appropriate wall/ceiling access panels, if required, shall be clearly shown on the coordination drawings.

I. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.

J. All fire and combination fire/smoke dampers shall be commissioned (tested) in the presence of Owner representative following installation and before the corresponding fan systems are turned on. Contractor shall open all access doors for the inspection and close all doors in the presence of the inspector.

K. Demonstrate re-setting of fire dampers to Owner's representative.

L. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators. Install flexible connectors with adequate flexibility to allow for all thermal, axial, transverse and torsional movement. Provide airtight seal.

M. Provide balancing dampers at points on supply, return, and exhaust systems where indicated on plans.

N. Set dampers to fully open position before testing, adjusting, and balancing.

O. Provide a high-efficiency takeoff with 45-degree entry for each branch connection.

P. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

Q. The use of splitter dampers is not acceptable.

R. Install remote damper actuators where the balance damper is not accessible. Field paint the remote actuator cap to match the adjacent ceiling finish.

1. In these areas, the contractor shall provide and install damper in ductwork and shall connect damper to terminal point in ceiling with Bowden control wire.
2. Install per manufacturer instructions.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 34 23
HVAC POWER VENTILATORS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Utility set fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on 760 FT.

1.4 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Performance ratings: Conform to ANSI/AMCA Standards 210 and 300. Fans must be tested in accordance with AMCA Publications 211 and 311 in an AMCA accredited laboratory and certified for air and sound performance. Fans shall be licensed to bear the AMCA ratings seal for air performance (AMCA 210).
2. Fans shall have a Fan Energy Index (FEI) rating that meets or exceeds requirements of the latest edition of ASHRAE 90.1.
3. Fans shall be licensed to bear the Air Movement and Control Association (AMCA) Certified Ratings Program (CRP) seal for FEI.
4. The Fan FEI rating shall be indicated on the design documents and manufacturer product submittals to allow for compliance verification by the building official.
5. Classification for Spark Resistant Construction shall conform to ANSI/AMCA Standard 99.
6. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3)
7. Comply with the National Electrical Manufacturers Association (NEMA) standards for motor and electrical accessories.
8. Each fan shall undergo a factory run test where fan RPM and amp draw are recorded. This information is available to the customer free of charge upon request.

B. References.

1. ANSI/AMCA Standard 99-10, “Standards Handbook”
2. ANSI/AMCA Standard 204-05, “Balance Quality and Vibration Levels for Fans”
3. ANSI/AMCA Standard 210-07, “Laboratory Methods of Testing Fans for Aerodynamic Performance Rating”
4. AMCA Publication 211-05, “Certified Ratings Program – Product Rating Manual for Fan Air Performance”
5. ANSI/AMCA Standard 300-08, “Reverberant Room Method for Sound Testing of Fans”
6. AMCA Publication 311-05, “Certified Ratings Program – Product Rating Manual for Fan Sound Performance”
7. AMBA - Method of Evaluating Load Ratings of Bearings ANSI-11 (r1999).
8. AMCA Standard 500-D-12, “Laboratory Methods of Testing Dampers for Rating”
9. OSHA guideline 1910.212 – General requirements for Machine Guarding. (www.osha.gov)
10. OSHA guideline 1910.219 – General requirements for guarding safe use of mechanical power transmission apparatus. (www.osha.gov)
11. OSHA guideline 1926.300 – General requirements for safe operation and maintenance of hand and power tools. (www.osha.gov)
12. UL/cUL 705, Power Ventilators

C. Submittals.

1. Provide dimensional drawings and product data on each centrifugal fan.
2. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
3. Provide outlet velocity of centrifugal fans and fan’s inlet and outlet sound power readings for the eight octave bands.
4. Strictly adhere to QUALITY ASSURANCE requirements as stated in section 1.4 of this specification.
5. Provide manufacturer’s certification that exhaust fan is licensed to bear the Air Movement and Control Association (AMCA) Certified Rating Seal for air performance and sound performance where applicable.
6. Provide manufacturer’s Installation, Operation and Maintenance manual (IOM), including instructions on safety information, receiving, handling, and storage, installation, electrical wiring diagrams, operation, maintenance, troubleshooting guide, and warranty.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and handling.

1. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
2. Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage, follow manufacturer's Installation, Operation and Maintenance manual.
3. Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

G. Warranty.

1. Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

   a. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the manufacturers' option when returned to the manufacturer, transportation prepaid.
   b. Motor Warranty is warranted by the motor manufacturer for a period of one year. Should motors furnished prove defective during this period, they should be returned to the nearest authorized motor service station.

2. PRODUCTS

2.1 UTILITY SET FANS

A. Acceptable manufacturers:

1. Greenheck
2. Or approved equivalent.

B. General:

1. Base fan performance at standard conditions (density 0.075 Lb/ft^3).
2. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
3. Each fan shall be direct drive in AMCA arrangement 4 according to drawings.
4. Normal operating temperature up to 104 Degrees Fahrenheit (40 Deg. Celsius).
5. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model and individual serial number.
6. Fans are to be equipped with lifting lugs.
7. Constructed of heavy gauge steel

8. After fabrication, untreated steel components go through a multi-stage cleaning and pre-treatment process before being finished with a high-performance powder coating having a minimum thickness of 2-4 mils, electrostatically applied and baked. Finish color shall be RAL-7023, concrete grey. Coating must exceed 1,000-hour salt spray under ASTM B117 test method. No uncoated metal fan parts will be allowed.

C. Fan Housing and Outlets

1. Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Fan shall be of airtight PermaLock™ construction with the scroll panel material formed and embedded into the side panels. All interior and exterior surface untreated steel shall be coated with a high-performance powder coating.
3. Arrangement 4 has fan wheel directly coupled to the motor shaft.
4. Housing and bearing support shall be constructed of bolted framework.
5. An OSHA compliant shaft guard shall be included to completely cover the shaft for arrangement 8 only.

D. Fan Wheel

1. The fan wheel shall be of the single width backward inclined centrifugal type.
2. Fan Wheel shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.
3. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

E. Fan Motors and Drive

1. AC induction motor type

a. Motors shall meet or exceed EISA (Energy Independence and Security Act) efficiencies. Motors to be NEMA T-frame, 690, 870, 1170, 1770 or 3500 RPM in 60 Hz, (720, 950, 1425 or 2900 in 50 Hz) Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC).

2. EC Motor type

a. Motors shall be open type enclosure and electronic commutation type motor (ECM) specifically designed for fan applications. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal. Motor shall be a minimum of 85% efficient at all speeds.

F. Fans shall be licensed to bear the AMCA ratings seal for air performance (AMCA 210) and sound performance (AMCA 300).

3. EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install fans systems as indicated on the contract drawings.

B. Install fans in accordance with manufacturer's Installation, Operation and Maintenance manual.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION

SECTION 23 36 00
AIR TERMINAL UNITS

1. GENERAL

1.1 SECTION INCLUDES

A. Variable volume terminal units.

B. Integral wiring and controls.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. References.

B. Submittals.

1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg.

C. Project record documents.

D. Operation and maintenance data.

1. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

E. Qualifications.

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

F. Regulatory requirements.

1. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

G. Warranty.

1. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

2. PRODUCTS

2.1 SINGLE DUCT VARIABLE VOLUME UNITS

A. See Drawings for further information.

B. Basic Assembly:

1. Casings: Minimum 22 galvanized steel.
2. Liner: Fiber-free internal liner.
3. Air Outlets: S slip and drive connections.
4. ARI Certified

C. Basic Unit:

1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 4 percent of design air flow at three (3) inches inlet static pressure.
3. Mount damper operator to position damper normally open or normally closed as required by the operation sequence.
4. On units with heating coils, provide minimum 9”x6” hinged and gasketed access door on bottom of unit to facilitate coil inspection.

D. Velocity Sensors: Removable multipoint array at air inlet.

E. Hot Water Heating Coil:

1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.
2. Provide factory-insulated coil bends.
3. Capacity: As scheduled.

2.2 WIRING

1. Factory-mount and wire controls. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source.
2. Factory mount transformer. Provide terminal strip in control box for field wiring of thermostat and power source.

3. Wiring Terminations: Wire fan and controls to terminal strip. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
4. Disconnect Switch: As scheduled.

2.3 CONTROLS

1. Direct digital controls: Contain in NEMA-1 enclosure with access panel sealed from air flow and mounted on side of unit. Factory-mount controls.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide ceiling access doors or locate units above easily removable ceiling components. In no instance shall units be installed in inaccessible locations.

C. Support units individually from structure. Do not support from adjacent ductwork.

D. Connect to ductwork in accordance with Section 23 31 13.

E. Verify that electric power is available and of the correct characteristics.

F. Maintain a minimum of 18” clearance in front of VAV controller.

G. Provide 3 straight duct diameters upstream of VAV box inlet.

H. Flexible duct connections to VAV boxes are not permitted.

3.2 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.3 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation as indicated on equipment schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 37 00
AIR OUTLETS AND INLETS

1. GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

1.2 REFERENCES

A. See Section 23 05 00.

1.3 SUBMITTALS

A. See Section 23 05 00.

1.4 PROJECT RECORD DOCUMENTS

A. See Section 23 05 00.

1.5 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate louver performance in accordance with AMCA 500. Submit AMCA certification with submittal.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

2. PRODUCTS

2.1 CEILING DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule.

2.2 WALL REGISTERS AND GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Types: Provide wall registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule.

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with adjustable elbow. Install maximum length of 5' of flexible duct upstream of each diffuser and grille, unless otherwise noted. See details on Drawings. All connections shall be air tight.

D. In laboratories with ventilated workstations, position diffusers so that airflow is directed parallel to the front of the workstation, not perpendicular to it.

E. Where diffusers are located near fume hoods, canopy hoods, biological safety cabinets, or other devices which are sensitive to air turbulence, install diffuser to direct airflow parallel to the front face of the device (i.e. not directed at device).

F. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly. Where a balancing damper has been omitted from drawing, consult engineer.

G. Paint ductwork visible behind air outlets and inlets matte black.

H. Provide return air sound boot on grilles as shown on drawings.

I. Where slot diffusers or linear diffusers are located near perimeter windows, adjust at least one slot to direct air toward window.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 52 00 – HEATING BOILERS

1. GENERAL

1.1 SECTION INCLUDES

A. This Section includes packaged, factory-fabricated and assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for space heating hot water.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

D. "ASHRAE/IESNA 90.1 Compliance" Paragraph may be required to comply with Project requirements or authorities having jurisdiction. Also, LEED Prerequisite EA 2 requires compliance with ASHRAE/IESNA 90.1.

E. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

F. ANSI Compliance: Boilers shall be compliant with ANSI Z21.13 test standards for US and Canada.

G. CSA Compliant: Boilers shall be compliant with CSA certification.

H. References.

1. ASME Section IV
2. CAN-1.3.1-77, Industrial and Commercial Gas Fired Packaged Boilers
3. CSD-1, Controls and Safety Devices
4. XL GAPS
5. NEC, National Electric Code
6. UL-795 7th Edition
7. AHRI, BTS-2000
8. ASHRAE 90.1-2010

I. Submittals.

1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: For boilers, boiler trim, and accessories.

    a. Include plans, elevations, sections, details, and attachments to other work.
    b. Wiring Diagrams: Power, signal, and control wiring.

3. Source quality-control test reports: Indicate and interpret test results for compliance with performance requirements before shipping.
4. Field quality-control test reports: Indicate and interpret test results for compliance with performance requirements.
5. Warranty: Standard warranty specified in this Section.

J. Operation and maintenance manuals.

K. Project record documents.

1. Complete parts list
2. Certified startup and combustion test record

L. Delivery, storage, and handling.

1. Handle boiler components and equipment carefully to prevent damage, breaking, and scoring. Do not install damaged components; replace with new.
2. Store boiler sections and equipment in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
3. Comply with manufacturer's rigging and moving instructions for unloading boilers, and moving them to final location.

M. Regulatory requirements

N. Coordination:

1. Mechanical contractor shall coordinate the size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete reinforcement and formwork requirements are specified in Division 03.

O. Warranty:

1. Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

a. Warranty Period for Fire-Tube Condensing Boilers:

1) Heat Exchanger, Pressure Vessel and Condensation Collection Basin shall carry a 10 year limited warranty against defects in materials or workmanship and failure due to thermal shock.
2) All other components shall carry a one year warranty from date of boiler start up.

2. PRODUCTS

2.1 BOILERS

A. Manufacturers:

1. Lochinvar Knight FTXL Boiler as specified on Drawings or approved equivalent.

B. Construction:

1. Description: Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
2. Heat Exchanger: The heater exchanger shall bear the ASME “H” stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded stainless steel and of fire tube design. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. Cast iron, aluminum, or condensing copper tube boilers will not be accepted.
3. Efficiency: Boilers shall have an AHRI certified minimum thermal efficiency of 97 percent.
4. Condensate Collection Basin: Fully welded stainless steel and shall include a stainless steel combustion analyzer test port.
5. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. The pressure vessel shall contain a volume of water no less than:

Model	Water Content
FTX400	13 gallons
FTX500	12 gallons
FTX600	12 gallons
FTX725	17 gallons
FTX850	16 gallons
FTX1000	19 gallons

6. Burner: Natural gas, forced draft single burner premix design. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency.
7. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.

    a. Motors: Comply with requirements specified in Division 23 Section "Electrical Requirements for Mechanical Equipment."

8. Gas Train: The boiler shall be supplied with a negative pressure regulation gas train and shall be capable of the following minimum turndowns:

Model	Turndown	Minimum Input	Maximum Input
FTX400	10:1	40,000	400,000
FTX500	10:1	50,000	500,000
FTX600	7:1	85,700	600,000
FTX725	7:1	103,500	725,000
FTX850	7:1	121,500	850,000
FTX1000	10:1	99,900	999,000

9. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
10. Casing:

    a. Jacket: Heavy gauge primed and painted steel jacket with snap-in closures.
    b. Control Compartment Enclosures: NEMA 250, Type 1A.
    c. If retaining second option in "Jacket" Subparagraph above, delete first subparagraph below.
    d. Insulation: Minimum ½ inch thick, mineral fiber insulation surrounding the heat exchanger.
    e. Combustion-Air Connections: Inlet and vent duct collars.

11. Characteristics and Capacities:

a. Heating Medium: Hot water.
b. Design Water Pressure Rating: 160 psi working pressure.
c. Safety Relief Valve Setting: 50 psig
d. Minimum Water Flow Rate:

Model	Minimum Flow
FTX400	10 gpm
FTX500	12 gpm
FTX600	15 gpm
FTX725	18 gpm
FTX850	21 gpm
FTX1000	30 gpm

C. Trim

1. Safety Relief Valve:

a. Size and Capacity: 50 lb.
b. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

2. Pressure Gage: Minimum 3-1/2 inch diameter. Gage shall have normal operating pressure about 50 percent of full range.
3. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.
4. Condensate Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium.

D. Controls

1. Refer to Division 23 Section "Instrumentation and Control for HVAC."
2. Boiler controls shall feature a standard, factory installed multi-color graphic LCD screen display with navigation dial and includes the following standard features:

a. Con-X-Us capable: Boiler shall have the ability to communicate remotely using the optional Con-X-Us software via a wireless or Ethernet connection.
b. Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
c. Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
d. PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
e. Maintenance reminder: Boiler shall have the ability to display a yellow colored, customizable maintenance notification screen. All notifications are adjustable by

the installer based upon months of installation, hours of operation, and number of boiler cycles.

f. English Error codes: Boiler shall have a user interface that displays a red error screen with fault codes that are displayed in English and include a date and time stamp for ease of servicing.

g. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.

h. Isolation valve control: Boiler shall have the ability to control a 2-way motorized control valve. Boiler shall also be able to force a fixed number of valves to always be energized regardless of the number of boilers that are firing.

i. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.

j. Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, space heat run hours, domestic hot water run hours and ignition attempts. All data should be visible on the boiler screen.

3. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:

a. Lead lag: The Control module shall allow only one boiler to fire at the beginning of a call for heat. Once the lead boiler is in full fire and the control calculates that additional heat is required it will call on an additional boiler as needed.

b. Efficiency optimization: The Control module shall allow multiple boilers to simultaneously fire at minimum firing rate in lieu of Lead/Lag.

c. Front end loading: The Control module shall allow the cascading and functional control of several non condensing Lochinvar products alongside the Knight FTXL.

d. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.

4. Boiler operating controls shall include the following devices and features:

a. Set-Point Adjust: Set points shall be fully adjustable by the installer.

b. Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.

5. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation and include:

a. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
b. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
c. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
d. High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
e. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
f. Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
g. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.

6. Building Automation System Interface:

a. Boiler shall have the ability to receive a 0-10V system from a building management system and control by the following:

1) 0-10V DC input to control Modulation or Setpoint
2) 0-10V DC input Enable/Disable signal

b. Factory installed Modbus gateway interface to enable building automation system to monitor, control, and display boiler status and alarms.

E. Electrical Power:

1. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
2. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
3. Electrical Characteristics:

a. See Drawings
b. Voltage

1) 120V / 1PH

c. Frequency: 60 Hz

F. Venting:

1. Exhaust flue must be Category IV approved CPVC, PP or stainless steel sealed vent material from one of the approved manufacturers listed in the Installation and Operation manual. Boilers exhaust vent length must be able to extend to 100 equivalent feet.
2. Intake piping must be of approved material as listed in the Installation and Operations manual. Boilers intake pipe length must be able to extend to 100 equivalent feet.
3. Boiler venting and intake piping configuration shall be installed per one of the approved venting methods shown in the Installation and Operation manual.
4. Boilers using common venting must only include like models and the optional common vent damper. Contact the factory for common vent sizing.
5. Boiler shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.
6. Refer to manufacturer's Installation and Operations manual for detailed venting instructions and approved manufacturers.

G. Source quality control

1. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
2. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

3. EXECUTION

3.1 EXAMINATION

1. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

    a. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

2. Examine mechanical spaces for suitable conditions where boilers will be installed.
3. Proceed with installation only after satisfactory conditions have been verified.

3.2 BOILER INSTALLATION

A. Install equipment on 4" concrete housekeeping pad.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of equipment connection. Provide a reducer if required.

E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Boiler Venting:

1. Install flue venting kit and combustion-air intake.
2. Connect full size to boiler connections. Comply with requirements in Division 23 Section “Breechings, Chimneys, and Stacks.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and inspections:

1. Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

5. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory representative or a factory-authorized service representative for boiler startup. Start-up sheet shall be completed and a copy shall be sent to the Engineer and the Manufacturer. A combustion analysis shall be completed and the gas valve adjusted per the Installation and Operations manual and note in start-up report.

B. Factory representative or a factory-authorized representative shall provide Owners training to instruct maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION

SECTION 23 74 13 – DEDICATED OUTDOOR AIR SYSTEM

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Specification section 23 05 00.

1.2 SUMMARY

A. This Section includes:

1. Energy recovery heating and cooling units.

B. Related Sections include the following:

1. Division 23 09 00 Section "Digital Control Equipment".

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of completed checklists.

D. Maintenance Data: Maintenance manuals specified in 23 05 00.

E. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Energy Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

C. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The rooftop unit(s) shall be certified in accordance with UL Standard 1995 and ANSI Standard Z21.47.
2. The rooftop unit(s) shall be safety certified by an accredited testing laboratory and the nameplate shall carry the label of the certification agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver rooftop units as factory-assembled units with protective crating and covering as recommended by the manufacturer.

B. Coordinate delivery of units in sufficient time to allow movement into building.

C. Handle rooftop units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

1.6 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations with roof construction.

1.7 WARRANTY

A. General Warranty

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed. (See section 3.5 A)

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Filters: One set of filters for each unit.

2. PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to strict compliance with the requirements of this specification, provide products by one of the following:

1. Rooftop Units:

a. Daikin
b. Trane
c. Aaon, Inc.
d. LG Air Conditioning Technologies
e. Or Approved Equivalent

B. GENERAL DESCRIPTION

1. Configuration: Fabricate as detailed on prints and drawings:

a. Return plenum / economizer section
b. Filter section
c. Cooling coil section
d. Supply fan section
e. Gas heating section.
f. Condensing unit section

2. The complete unit shall be cETLus listed.
3. The unit shall be ASHRAE 90.1-2016 compliant and labeled.
4. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.
5. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
6. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.

7. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.
8. Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

C. CABINET, CASING, AND FRAME

1. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
2. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16” at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.
3. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
4. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

D. OUTDOOR/RETURN AIR SECTION

1. Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.
2. Low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from

multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.

3. Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when supply fan starts, and close when supply fan stops.

E. ENERGY RECOVERY

1. The fixed plate energy recovery core is equipped with a bypass damper on the outside air path. If the RTU has an economizer internal to it then the bypass damper will open when the unit enters the economizer operating state and close when the unit leaves the economizer operating state.
2. When the outside air is below 32F (adjustable) the bypass damper will open for 5 minutes (adjustable) every 60 minute period (adjustable). Exhaust air continues to run though the core during this time to remove frost buildup.
3. The ERV core shall transfer both sensible and latent energy between the incoming fresh air stream and the exhaust stale air stream.
4. The ERV core shall be in either a cross-flow or counter cross-flow orientation and have no moving parts.
5. The ERV core shall be certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. Products not currently AHRI certified will not be accepted.
6. The ERV core shall achieve the minimum effectiveness value as indicated in the schedule.
7. The fresh air stream must have complete separation from the stale air stream to prevent cross contamination.
8. The ERV core shall have Exhaust Air Transport Ratio of 0.5% as tested to AHRI 1060 (EATR) to prevent cross-over of gases, contaminants or odors.
9. The ERV core's Outdoor Air Correction Factor (OACF) shall not exceed 1.0 as tested to AHRI 1060 (OACF) Standard.
10. The ERV core shall not be degraded or promote the growth of mold and bacteria with a rating of zero in testing according to ISO846 A and C.
11. The ERV core must be able to tolerate freezing temperatures of -30°C (-22°F and not have an increase in EATR or decrease in performance after being frozen.
12. The ERV core must be able to tolerate high temperatures of +60°C and not have an increase in EATR or decrease in performance at these elevated temperatures.
13. The ERV core must be freeze tolerant tested to 40 freeze thaw cycles from -20¬o C to +20o C while maintaining the energy recovery effectiveness and EATR rating of 0.5%.
14. The ERV core must be water washable to remove dust and contaminants.
15. The ERV core must be flame proof and comply with UL 723 with a flame spread index that shall not be over 25 and a smoke index that shall not be over 50.
16. The ERV cores should have particulate filters positioned before the incoming air streams.
17. Accepted manufacturer: CORE Energy Recovery Solutions or approved equal, subject to compliance with requirements

F. EXHAUST FAN

1. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
2. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
3. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

G. FILTERS

1. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2” prefilter and a 4” final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2” MERV 8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

H. COOLING COIL

1. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
2. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
3. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
4. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
5. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

I. HOT GAS REHEAT

1. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser
2. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.
3. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.
4. Each coil shall be factory leak tested with high-pressure air under water.

J. SUPPLY FAN

1. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additonal maintenance.
2. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
3. Supply fan and motor assembly combinations larger than 8 hp or 22” diameter shall be internally isolated on 1” deflection, spring isolators and include removable shipping tie downs.
4. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
5. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

K. HEATING SECTION

1. The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.
2. The module shall be complete with furnace controller and control valve capable of 10:1 modulating operation.
3. The heat exchanger tubes shall be constructed of
4. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.

5. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.
6. The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

L. CONDENSING SECTION

1. Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
2. Outdoor air coils shall be protected from incidental contact to coil fins by a coil guard. Coil guard shall be constructed of cross wire welded steel with PVC coating.
3. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 25~120°F. Mechanical cooling shall be provided to 25º F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
4. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.
5. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and an oil separator for each compressor that routes oil back to the compressor instead of through the discharge line.
6. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
7. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.
8. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

M. ELECTRICAL

1. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical

components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

2. A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

N. CONTROLS

1. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.
2. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
3. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
4. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
5. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
6. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-

up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:

a. Return air temperature.
b. Discharge air temperature.
c. Outdoor air temperature.
d. Space air temperature.
e. Outdoor enthalpy, high/low.
f. Compressor suction temperature and pressure
g. Compressor head pressure and temperature
h. Expansion valve position
i. Condenser fan speed
j. Inverter compressor speed
k. Dirty filter indication.
l. Airflow verification.
m. Cooling status.
n. Control temperature (Changeover).
o. VAV box output status.
p. Cooling status/capacity.
q. Unit status.
r. All time schedules.
s. Active alarms with time and date.
t. Previous alarms with time and date.
u. Optimal start
v. Supply fan and exhaust fan speed.
w. System operating hours.

1) Fan
2) Exhaust fan
3) Cooling
4) Individual compressor
5) Heating
6) Economizer
7) Tenant override

7. The user interaction with the keypad shall provide the following:

a. Controls mode

1) Off manual
2) Auto
3) Heat/Cool
4) Cool only
5) Heat only
6) Fan only

b. Occupancy mode

1) Auto
2) Occupied
3) Unoccupied
4) Tenant override

c. Unit operation changeover control

1) Return air temperature
2) Space temperature
3) Network signal

d. Cooling and heating change-over temperature with deadband
e. Cooling discharge air temperature (DAT)
f. Supply reset options

1) Return air temperature
2) Outdoor air temperature
3) Space temperature
4) Airflow (VAV)
5) Network signal
6) External (0-10 vdc)
7) External (0-20 mA)

g. Temperature alarm limits

1) High supply air temperature
2) Low supply air temperature
3) High return air temperature

h. Lockout control for compressors.
i. Compressor interstage timers
j. Night setback and setup space temperature.
k. Building static pressure.
l. Economizer changeover
m. Enthalpy

1) Drybulb temperature
2) Currently time and date

n. Tenant override time
o. Occupied/unoccupied time schedule
p. One event schedule
q. Holiday dates and duration

r. Adjustable set points
s. Service mode

1) Timers normal (all time delays normal)
2) Timers fast (all time delays 20 sec)

8. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:

a. Zone sensor with tenant override switch
b. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)

9. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:

a. Airflow
b. Outside air temperature
c. Space temperature
d. Return air temperature
e. External signal of 1-5 vdc
f. External signal of 0-20 mA
g. Network signal

3. EXECUTION

3.1 EXAMINATION

A. Verification of existing conditions prior to beginning work.

B. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

C. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 90A.

C. Mount units on factory-built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

3.3 MANUFACTURER'S FIELD SERVICES

A. Provide initial start-up and shut-down during first year of operation, including routine servicing and check-out.

3.4 Provide services of factory trained representative for start-up, leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct.

3.5 WARRANTY

A. Entire unit to have a complete 1 year parts and labor warranty following date of substantial completion. Provide an extended 5 year parts and labor warranty on the integral controls and all components of the refrigerant circuits system including compressors

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 81 26 – SPLIT SYSTEMS

1. GENERAL

1.1 SECTION INCLUDES

A. Ductless split system with outdoor condensing units and indoor fan coil unit.

1.2 RELATED SECTIONS

A. Section 23 05 13 – Electrical Requirements for Mechanical Equipment.

B. Section 23 05 93 – Testing, Adjusting and Balancing.

1.3 REFERENCES

A. ARI 210 - Unitary Air-Conditioning Equipment.

B. ARI 240 - Unitary Air-Conditioning Equipment.

C. ARI 270 - Sound Rating of Outdoor Unitary Equipment.

D. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

E. IECC and ASHRAE 90.1 - Energy Conservation in new Building Design.

1.4 SUBMITTALS FOR REVIEW

A. Reference section 23 05 00.

B. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Include schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system.

C. Product Data: Provide rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Reference section 23 05 00.

B. Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.

1.6 QUALITY ASSURANCE

A. Unit will be rated in accordance with the latest edition of ARI Standard 210.

B. Unit will be certified for capacity and efficiency, and listed in the latest ARI directory.

C. Unit construction will comply with latest edition of ANSI/ ASHRAE and with NEC.

D. Unit will be constructed in accordance with UL standards and will carry the UL label of approval.

E. Unit will have UL approval.

F. Unit cabinet will be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500-hr salt spray test.

G. Air-cooled heat pump and cooling coil condenser coils will be leak tested at 150 psig and pressure tested at 450 psig.

1.7 Unit constructed in ISO 9001 approved facility

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from physical damage. Protect coils.

1.9 WARRANTY

A. Warranties

B. Provide a five year warranty to include coverage for refrigerant compressors.

2. PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM

A. Indoor, wall-mounted, direct-expansion fan coil shall be matched with the commercial condensing units.

B. Unit shall be rated per ARI Standards 210 and listed in the ARI directory as a matched system.

C. Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall-mounting bracket and mounting hardware, and thermistor interconnection cable.

1. Unit Cabinet: Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.
2. Fans: Fan shall be tangential direct-drive blower type with air intake at the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard air sweep operation shall be user selectable. Horizontal direction may be manually adjusted (using remote controller) and vertical air sweep may be manually set.
3. Coil: Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header.
4. Motors: Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.
5. Controls: Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self diagnostics. The temperature control range shall be from 64 F to 84 F. The unit shall have the following functions as a minimum.

    a. An automatic restart after power failure at the same operating conditions as at failure.
    b. A timer function to provide a minimum 24-hour timer cycle for system Auto. Start/Stop.
    c. Temperature-sensing controls shall sense return-air temperature. Indoor-air high discharge temperature shutdown shall be provided.
    d. Indoor coil freeze protection.
    e. Wired controller to enter set points and operating conditions.
    f. Auto Stop features shall have integral setback control.
    g. Automatic airsweep control to provide on or off activation of airsweep louvers.
    h. Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.
    i. Fan only operation shall provide room air circulation when no cooling is required.

j. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit and at the remote controller.
k. An indoor to outdoor thermistor connection cable shall be provided with the fan coil unit.
l. Fan speed control shall be user-selectable: high, medium, low, or microprocessor automatic operation during all operating modes.
m. A time delay shall prevent compressor restart in less than 3 minutes.
n. Automatic heating-to cooling changeover to provide automatic heating and cooling operation. Control shall include deadband to prevent rapid mode cycling.
o. Demand defrost shall be provided and shall minimize defrost cycles by internally adjusting defrost timing based on frost accumulation.
p. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature when unit is in heat pump mode.

6. Filters: Unit shall have filter track with factory-supplied cleanable filters.
7. Electrical Requirements: Refer to the schedule for electrical requirements. Power and control connections shall have terminal block connections.
8. Operating Characteristics: Refer to schedule for performance requirements.

D. Commercial Condensing Units

1. Outdoor-mounted, air-cooled split system outdoor section suitable for rooftop installation.
2. Unit shall consist of a hermetic or rotary compressor, an air-cooled coil, propeller-type blow-thru outdoor fans, accumulator, full refrigerant charge, and control box. Unit shall discharge air horizontally as shown on the contract drawings. Units shall function as the outdoor component of an air-to air cooling system.
3. Units shall be used in a refrigeration circuit matched to a duct-free cooling fan coil unit.
4. Unit construction shall comply with ANSI/ASHRAE 15, latest revision, and with the NEC. Units shall be constructed in accordance with UL standards. Units shall be listed in the CEC directory. Unit cabinet shall be capable of withstanding Federal Test Standard No. 141 (method 6061) 500-hour salt spray test.
5. Air-cooled condenser coils shall be leak tested for R-410A operating pressures with the coil submerged in water.
6. Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, full charge of R-410A refrigerant, and special features required prior to field start-up.
7. Unit Cabinet: Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish.
8. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
9. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.
10. Fans: Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall blow air through the outdoor coil.
11. Outdoor fan motors shall be totally enclosed; single-phase motors with class B insulation and permanently lubricated sleeve bearings. Motor shall be protected by internal thermal overload protection.

12. Shaft shall have inherent corrosion resistance.
13. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
14. Outdoor fan openings shall be equipped with PVC coated protection grille over fan and coil.
15. Compressor: Compressor shall be fully hermetic reciprocation or scroll type.
16. Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from overtemperature and overcurrent. Scroll compressors shall also have high discharge gas temperature protection if required.
17. Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere.
18. Reciprocating compressors shall be equipped with crankcase heaters to minimize liquid refrigerant accumulation in compressor during shutdown and to prevent refrigerant dilution of oil.
19. Compressor assembly shall be installed on rubber vibration isolators and shall have internal spring isolation. Compressors shall be single-phase or 3-phase as specified on the contract drawings.
20. Outdoor Coil: Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes, which are cleaned, dehydrated, and sealed.
21. Refrigeration Components: Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, pressure relief, and a full charge of refrigerant.
22. Controls and Safeties: Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control shall include the following:

    a. Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
    b. Automatic restart on power failure.
    c. Safety lockout if any outdoor unit safety is open.
    d. A time delay control sequence provided through the fan coil board, thermostat, or controller.
    e. High-pressure and liquid line low-pressure switches.
    f. Liquid line low-pressure switches.
    g. Automatic outdoor-fan motor protection.

23. Start capacitor and relay (single-phase units without scroll compressors).
24. The minimum safeties shall include the following:

    a. System diagnostics.
    b. Compressor motor current and temperature overload protection.
    c. High-pressure relief.
    d. Outdoor fan failure protection.

25. Electrical Requirements: Refer to schedule for electrical requirements. Unit electrical power shall be a single point connection. All power and control wiring must be installed per NEC and all local building codes. High and low voltage terminal block connections.
26. Special Features:

a. Low-Ambient Kit: Control shall regulate fan-motor cycles in reponses to saturated condensing, pressure of the unit. The control shall be capable of maintaining a condensing temperature of 100 F ± 10 F with outdoor temperatures to –20 F. Installation of kit shall not require changing the outdoor-fan motor.
b. Winter Start Control: Field supplied and installed winter start control shall permit start-up for cooling operation under low-load conditions and at low-ambient temperatures by bypassing the low-pressure switch for a 3-minute delay period.
c. Crankcase Heater (units with scroll compressors only):
d. Unit shall be shipped with a clamp-on compressor oil sump heater.
e. Hard Start Kit: Field installed accessory start capacitor and start relay shall give a hard boost to compressor motor at each start.
f. Wind Baffle Kit: Shall be fabricated sheet metal wrapper used to provide improved unit operation during high winds.

3. EXECUTION

3.1 EXAMINATION

A. Verify that required utilities are available, in proper location, and ready for use.

B. Beginning of installation means installer accepts existing surfaces.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Protect units with protective covers during balance of construction.

C. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.

D. Provide for connection to electrical service.

E. Provide connection to refrigeration piping system and evaporators. Refer to Section 232300. Comply with ASHRAE 15.

F. Furnish charge of refrigerant and oil.

3.3 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filters.

3.4 DEMONSTRATION AND INSTRUCTIONS

A. Section 23 05 00 demonstrating installed work.

B. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.

C. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.

D. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

E. Provide cooling season start-up, and winter season shut-down for first year of operation.

F. Inspect and test for refrigerant leaks every three months during first year of operation.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 84 13 - HUMIDIFIERS

1. GENERAL

1.1 SECTION INCLUDES

A. Gas-fired steam humidification system.

1.2 REFERENCES AND REGULATORY REQUIREMENTS

A. See Section 23 05 00.

B. Certifications:

1. CE – Gas Appliance Regulation (GAR), LVD, EMC
2. CSA/AGA/CGA ETL
3. SCAQMD 1146.2 for low Nox

1.3 SUBMITTALS

A. See Section 23 05 00.

1. Comply with submittal procedures and execution and closeout requirements in this section.
2. Submit product data (manufacturer's specifications and technical data including performance, construction, and fabrication) for each manufactured component.

1.4 Warranty

A. Product shall be warranted to be free from defects in materials and fabrication for a period of two years after installation or 27 months from manufacturer ship date, whichever date is the earlier.

1.5 OPERATION AND MAINTENANCE DATA

A. See Section 23 05 00.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years documented experience.

1.7 DELIVERY, STORAGE AND HANDLING

A. See Section 23 05 00.

1.8 SEQUENCING AND SCHEDULING

A. See Section 23 05 00.

2. PRODUCTS

2.1 HUMIDIFICATION SYSTEM

A. System: Humidification system shall include a steam generator, steam dispersion assembly, control equipment, and accessories.

B. Steam generator: Steam generator shall be by a gas-to-steam evaporative steam humidifier manufactured by Dri-Steem or equal meeting the specifications here within.

C. Fabrication requirements:

1. Tank and primary heat exchanger: 14-gauge 304-stainless steel with water side welded seams for all water-submerged welds.
2. Humidifier shall include a 316 stainless steel secondary heat exchanger to pre-heat inlet water and combustion air using exhaust gasses exiting the primary heat exchanger.
3. Tank bottom shall be slanted with drain port at bottom of tank to ensure complete draining.
4. Steam outlet on top of tank configured to connect to hose and pipe (NPT or BSP connection) for units up to 150 lbs/hr, and only pipe (NPT, BSP, or flange connection) for units from 200 lbs/hr to 600 lbs/hr.
5. Humidifier must be designed and approved by manufacturer to safely operate with PVC flue venting.
6. Unit shall include adaptable fittings to utilize PVC, CPVC, polypropylene inlet and flue venting material as required by local codes.
7. Include removable cover allowing easy access to water sensing assembly in the tank.
8. Tank shall have an easily accessible cleanout plate.
9. Indoor humidifier shall have a painted aluminum enclosure to protect all humidifier components and have an integral base with openings designed for moving humidifier with a forklift or pallet jack.
10. Humidifier tank shall be insulated with 1/2"-thick (12.5 mm), K-Flex closed cell insulation.
11. Units shall be capable of fitting through a 36" (91 mm) wide door.
12. Humidifier shall have sealed combustion plumbed to the unit shroud.
13. Tank and primary heat exchanger shall be 316 stainless steel with water side welded seams for all water-submerged welds.

D. Water type, fill, and drain requirements:

1. Water type: Humidifier shall be capable of generating steam from RO water.

2. The humidifier shall not require changes to controls or components in the field due to changes in the water type.
3. The humidifier shall sense water purity and automatically adjust drain rates accordingly to minimize tank maintenance and optimize water usage.
4. Fill and drain line piping shall include anti-siphoning mechanisms that prevent tank siphoning and potential inlet water contamination.
5. Humidifier shall incorporate a water surface skimming feature to drain away water surface debris and contaminants to minimize tank cleaning maintenance and risk of foaming.
6. An electric drive valve shall be mounted on humidifier assembly to allow tank to drain automatically at the end of a humidification season.

    a. Provide complete tank draining with no standing water.
    b. Minimum 5 gpm flow rate for fast draining.
    c. The system shall monitor drain water temperature with temperature viewable on the unit's display.

7. Integral water tempering control shall meter cold water at the drain in order to temper 212°F (100°C) water to a maximum 140°F (60°C) discharge temperature at full drain rate to sanitary system during normal operation.

    a. Drain water tempering shall employ closed loop feedback using the drain temperature sensor to automatically control the drain and fill valves. Drain water temperature shall not exceed 140 °F (60 °C) while system shall minimize (cold) water usage by not excessively tempering.
    b. Minimize drain and refill time by sensing when water is no longer draining (tank empty) to quickly initialize refilling of tank and subsequent re-start of humidification.

E. Burner assembly:

    a. Humidifier and burner assembly shall be CSA/AGA/CGA/ETL certified and tested to support natural gas or LP gas.
    b. Gas train assembly shall be complete with burner/mixing tube assembly, igniter, sight glass, flame rod electrode, gas manifold, integral gas valve and venturi.
    c. Each burner shall freely modulate with a gas input turndown ratio of at least 5:1.

F. Humidifier performance:

    a. Unit shall be of a condensing design utilizing a secondary heat exchanger to achieve average thermal efficiencies of over 93%.
    b. The high-efficiency humidifier shall be certified by South Coast Air Quality Management District (SCAQMD) to meet low NOx requirements of Rule 1146.2.

G. Markings showing certifications, electrical warnings, and connections to gas, vent, combustion air, water supply and drain shall be on unit.

H. Internal water tempering device: A factory-installed thermostatically controlled water valve shall meter an amount of cold water into a stainless steel mixing chamber to temper 212 deg F water with a 6 gpm in-flow rate to a 140 deg F discharge temperature to sanitary system.

I. Unit shall automatically perform a tempered drain upon power interruption using a normally open drain valve and thermostatically controlled valve.

J. Humidifier Controls:

1. Control subpanel: Control subpanel shall be factory-attached to humidifier with all wiring between subpanel and humidifier completed at factory. A wiring diagram shall be included.
2. Vapor-logic microprocessor controller with the following features or functions:

    a. Touchscreen user interface shall be included standard on all models

        1) Minimum 5” (125 mm) diagonal 800 x 480 24 bit RGB color display
        2) Touch-sensitive screen control including swipe-scrolling of lists
        3) Display operable within a temperature range of 32 to 158 °F (0 to 70 °C)
        4) Animated graphical display of humidifier operating conditions
        5) Icon-based function keys on screen with consistent Home option to facilitate navigation
        6) Setup wizard, context-sensitive Help screens and output test functions for unit commissioning
        7) On-screen QR Code links to humidifier installation literature
        8) Prioritized color-coded alerts with time & date of occurrence, including log of up to 60 prior event messages.
        9) Unit name information; editable with full qwerty on-screen keyboard.
        10) Adjacent four-color LED status light of humidifier operating condition

    b. Web interface and server, included standard on all models:

        1) Web interface shall have same functionality as Vapor-logic touchscreen display
        2) Web interface shall allow multiple remotely located users to simultaneously view system operation and/or change system parameters.
        3) Web interface shall have password-protected secure access.
        4) Web interface shall be compatible with standard Internet browsers.
        5) Web interface shall connect directly to a personal computer or through a system network via Ethernet cable.

3. Touchscreen display shall be factory mounted on humidifier.
4. Controller shall provide redundant tank over-temperature and flue over-temperature safety control using inputs from the tank temperature sensor and flue temperature sensor.

5. Humidifier shall have tank over-temperature switch and flue over-temperature switch operating independently of the tank temperature sensor and flue temperature sensor.
6. Include flue temperature sensing to temporarily reduce humidifier output if flue temperatures approach maximum, and to disable unit should maximum flue temperature be reached.
7. Controller shall provide fully modulating control of humidifier capacity.
8. Controller shall provide PID control capability with field-adjustable settings.
9. Water level control:

    a. Automatic refill, low water cutoff, surface skimming and automatic drain-down of humidifier. System shall consist of:

        1) A water level sensing unit comprised of three metallic probes mounted in probe head. Probe head shall incorporate probe isolation chamber to eliminate fouling caused by mineral coatings.
        2) Fill valve assemblies factory mounted on the humidifier assembly.
        3) End-of-season drain automatically drains humidifier tank after a user-defined period of system inactivity.

10. Tank temperature sensor: A factory mounted sensor, with a temperature range of -40 to 248 °F (-40 to 120 °C) mounted on the humidifier to enable the following functions:

    a. Maintain the evaporating chamber water temperature above freezing
    b. Maintain a user-defined preset evaporating chamber water temperature
    c. Allow rapid warm-up of water in evaporating chamber after a call for humidity, providing 100% operation until steam production occurs

11. USB port on the control board and touchscreen for software updates, data backups, and data restoration.
12. Up-time optimizer function to keep humidifier(s) operating through conditions such as fill, drain, or run-time faults, as long as safety conditions are met, minimizing production down-time.
13. Real-time clock to allow time-stamped alarm/message tracking, and scheduled events.
14. Factory commissioning of humidifier and control board, including system configuration as-ordered, factory unit testing, and operation with water before shipping.
15. Alarms, unit configuration, and usage timer values shall remain in nonvolatile memory indefinitely during a power outage.
16. The capability to monitor, control, and/or adjust the following parameters:

    a. Relative humidity (RH) set point, actual conditions in the space (from humidity transmitter), RH offset
    b. Dew point set point, actual conditions in the space (from dew point transmitter), dew point offset
    c. Relative humidity (RH) duct high limit set point (switch) and actual conditions
    d. Relative humidity (RH) duct high limit set point, actual conditions (from transmitter), high limit span, and high limit offset

e. Total system demand in % of humidifier capacity
f. Total system output in lbs/hour (kg/h)
g. Drain/flush duration, allowed days, and frequency based on usage.
h. End-of-season drain status and hours humidifier is idle before end of season draining occurs
i. Window glass surface temperature (in % RH offset application using sensor ordered as an option) with programmable offset
j. Air temperature or other auxiliary temperature monitoring with programmable offset (using sensor ordered as an option)
k. System alarms and system messages, current and previous
l. Adjustable water skim duration
m. Programmable outputs for remote signaling of alarms and/or messages, device activation (such as a fan), or for signaling tank heating and/or steam production
n. System diagnostics that include:

1) Test outputs function to verify component operation
2) Test humidifier function, by simulating demand to validate performance
3) Data collection of RH, water use, energy use, alarms, and service messages for download to USB.

o. Password-protected system parameters
p. Touchscreen display or Web interface displays in English, French, Spanish, Dutch or German languages
q. Numerical units displayed in inch-pound or SI units

17. Interoperability using BACnet MS/TP or BACnet IP.
18. Control input accessory options:

a. Humidity transmitter, duct: Humidity transmitter shall be a duct-mounted device that measures from 0% to 100% RH range and provides a linear output (10% to 90% RH) from 4 to 20 mA. Accuracy ± 2% RH. Supply voltage 21 VDC. Operating temperature range: -4 to 140 °F (-20 to 60 °C).
b. Humidistat, on-off, high limit: Electric humidistat control shall be an on-off style, duct mounted with a control range of 15% to 95% RH. Compatible with 24, 120, and 240 VAC. Operating temperature range 40 to 125 °F (4 to 52 °C).
c. Airflow proving switch, pressure type: Airflow proving switch shall be diaphragm-operated with pitot tube for field installation. Switch shall have an adjustable control point range of 0.05" to 12" wc (12.5 to 2988 Pa) Operating temperature range -40 to 180 °F (-40 to 82 °C). Compatible with 24, 120, and 240 VAC.

K. Humidifier accessories

1. Condensate neutralizer: Flue condensate is acidic with a 2-4 pH range. Provide a condensate neutralizer to treat condensate that forms in flue piping and the humidifier's secondary heat exchanger. Neutralizer to contain media that neutralizes the condensate water, raising the pH to near neutral. The neutralizer shall be piped so to drain both flue

and heat exchanger condensate to the neutralizer inlet. Drain piping to and from neutralizer shall be unrestrictive to prevent condensate backup into humidifier heat exchanger. Neutralizer life shall be size to perform a minimum one year at 30% humidifier run hours, to be replaced when discharge condensate pH fall below 5.0.

L. Humidification dispersion: Humidification steam shall be dispersed by DriSteem Ultra-sorb Model LV Steam Dispersion Panel or equal meeting specifications here within:

1. Performance: Dispersion assembly shall disperse evaporative, non-pressurized humidification steam into ducted or open spaces.
2. High-efficiency dispersion:

    a. Dispersion tubes shall be insulated with a plenum-approved insulating material for in-duct installation and have an R-value not less than 0.5 at a thickness not more than 0.125" (3.2 mm), for minimal increase in dispersion tube diameter.
    b. Airstream heat gain shall not exceed the values as scheduled; the values shall be supported by the manufacturer's published data.
    c. Insulating material shall meet the following criteria at 0.125" (3.2 mm) thickness:

        1) Fire/smoke index shall be 0/0 per any of the following test procedures:

            a) UL 723 fire/smoke index (Test for Surface Burning Characteristics of Building Materials)
            b) NFPA 255 (Standard Method of Test of Surface Burning Characteristics of Building Materials)
            c) ASTM E84 (Surface Burning Characteristics for Materials Used in Plenums)

        2) Stable up to 300 °F (148 °C) continuous — to prevent material degradation, hardening, or crumbling at high temperatures
        3) Closed-cell construction that does not absorb water or support microbial growth — to negate the need for vapor barriers and jackets
        4) Non-toxic and pure as documented in manufacturer's data — to prevent off-gassing and to facilitate use in clean rooms, pharmaceutical applications, and food industries
        5) Will not degrade when exposed to UVC light — to negate the need for UV wraps
        6) Continuous, seam-welded, and held in place without bands or clamps — to minimize surfaces for the accumulation of particulate matter

3. Absorption: See schedule on drawings for required absorption distance.
4. Fabrication and components: Dispersion tube panel shall include steam dispersion tubes spanning the distance between the two headers, a steam supply header/separator, a condensate collection header, and a metal casing.

a. Dispersion tubes:

1) Each tubelet shall extend through the wall of the dispersion tube and incorporate a properly sized calibrated orifice.
2) Dispersion tubes shall have two rows of steam discharge tubelets and shall discharge steam in diametrically opposite directions perpendicular to airflow
3) Tubelets shall be constructed of high-temperature resin
4) Tubes shall be joined to headers with slip-fit couplings to facilitate easy removal.

b. Header material: Headers shall be constructed of 304 stainless steel with welded seams.

c. Dispersion panel casing:

1) Each packaged humidifier panel assembly shall be contained within a steel casing to allow convenient duct mounting, or to facilitate the stacking of and/or the end-to-end mounting of multiple humidifier panels in ducts or air handler casings.
2) Casing assembly shall be 304 stainless steel.

M. Humidification dispersion: Humidification steam shall be dispersed by DriSteem Ultra-sorb Model LV Steam Dispersion Panel or equal meeting specifications here within:

N. Piping between steam generator and humidification dispersion panel: Refer to specification section 23 21 13 Hydronic Piping.

3. EXECUTION

3.1 INSTALLATION

A. Install per manufacturer's printed instructions and as indicated on drawings. Coordinate electrical connections as specified in Division 26.

3.2 FIELD QUALITY CONTROL:

A. Start-up: Upon completion of installation of units, provide start-up by factory authorized and trained operators and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance. Manufacturer's representative shall submit a letter to the Architect/Engineer certifying the equipment is operating properly and in accordance with this specification.

3.3 TRAINING:

A. Schedule training with Owner. The manufacturer's representative and the Division 23 contractor shall be present. The training shall be coordinated by the Division 23 contractor and the Owner in conjunction with the other mechanical equipment on the project.

1. Train the Owner's maintenance personnel on start-up and shut-down procedures, troubleshooting procedures, and servicing and preventative maintenance schedules and procedures. Review with the Owner's personnel, the contents of the Operating and Maintenance Data specified in Division 1 and Section 23 05 00.
2. Schedule training with Owner with at least seven (7) days prior notice.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 00 - ELECTRICAL GENERAL PROVISIONS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1-specification sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. The work included under this Section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete electrical systems required by these specifications and/or shown on the drawings of the contract.

B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, conduit, and outlets. Follow the drawings in laying out the work and verify spaces for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Engineer before proceeding with the work.

C. Portions of this facility (as indicated on the drawings) are classified as an animal facility/vivarium. All penetrations into the animal facility must be adequately sealed as outlined within the drawings and these specifications.

1.3 QUALITY ASSURANCE

Installers shall have at least 2 years of successful installation experience on projects with electrical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation.

1.4 REFERENCES

A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following codes, standards and regulations, etc.:

1. Safety and Health Regulations for Construction.
2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
3. National Electrical Code (NEC).
4. American National Standards Institute (ANSI).
5. National Electric Manufacturer's Association (NEMA).
6. Institute of Electrical and Electronic Engineers (IEEE).
7. National Fire Protection Association (NFPA).

8. Insulated Cable Engineers Association (ICEA).
9. American Society for Testing and Materials (ASTM).
10. Life Safety Code NFPA #101.
11. Underwriters Laboratories, Inc. Standards (UL).
12. Factory Mutual Engineering Corporation or other recognized National Laboratories.
13. National Electrical Safety Code (NESC).

B. The latest adopted edition by the local and state inspection authorities of all standards and specifications listed above shall apply.

C. Furthermore, the electrical work shall be in accordance with all applicable National and State Standards, and Local Codes and Building Ordinances. The electrical work shall merit the approval of the enforcing authorities having jurisdiction.

1.5 MATERIALS AND EQUIPMENT

A. Electrical materials and equipment for the entire project shall meet the requirements specified under the Supplementary Conditions Section of this specification.

B. Equipment and fixtures shall be connected to provide circuit continuity in accordance with applicable Codes whether or not each piece of conductor, conduit, or protective device is shown between such items of equipment or fixtures and the point of circuit origin.

C. The electrical work includes the installation or connection of certain materials and equipment furnished by others. Verify all connection details.

D. All equipment over 50 pounds shall be provided with adequate lifting means.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 ACCESS TO EQUIPMENT

A. Starters, switches, receptacles, pull boxes, etc. shall be located to provide easy access for operation, repair and maintenance. If the devices listed above are concealed, access doors shall be provided.

3.2 SUBMITTALS

A. Test Reports: Provide the tests as outlined in this specification and all other tests necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each electrical system. Provide the Engineer with a complete schedule of all tests.

1. Ground Rod Test: Immediately after installation, test driven grounds and counterpoises with a ground resistance direct-reading single-test megger, using the AC fall-of-potential method and two reference electrodes. Orient the ground to be tested and the two reference electrodes in a straight line spaced 50 feet apart. Drive the reference

electrodes five feet deep. Disconnect the ground rod to be tested from other ground systems at the time of testing. The ground resistance for the electrical service must be 15 Ohms or less. Submit the results, date of test, and soil conditions to the Engineer in writing immediately after testing.

2. Final Tests: Start final tests after complete preliminary tests have been made which indicate adequacy, quality, completion, and satisfactory operation of all electrical systems. Included in these tests are the following:

    a. Completion of the form "Electrical Test Report" (attached to the end of this specification section) in sufficient quantity to provide the indicated information for each panelboard and switchboard in the project.
    b. Completion of the form "Motor Test Report" (attached to the end of this specification section) in sufficient quantity to provide the indicated information for all three phase motors.

3. The Contractor shall submit the above completed reports to the Engineer, noting all deviations from the requirements listed below:

    a. Plus or minus five percent variation between nominal system voltage and no load voltage, or plus or minus five percent variation between no load and full load voltage.
    b. Plus five-percent variation between rated and actual motor current.
    c. Plus or minus ten percent variation between average phase current and measured individual phase current. The Contractor shall balance phase currents of all distribution equipment within the tolerances specified.
    d. Insulation resistance between conductors and ground of not less than 1,000,000 Ohms.

4. Final Corrections: Correct promptly any failure or defects revealed by these tests as determined by the Engineer. Reconduct tests on corrected items as directed by the Engineer.

B. Operation and Maintenance Manuals: Operation and Maintenance Manuals shall be provided according to Division 1 requirements. In general, during the time of the contract, and before substantial completion of the electrical installation, submit to the Engineer the number of copies described in the Division 1 specifications and the General and Supplemental Conditions copies of descriptive literature, maintenance recommendations (from the equipment manufacturer), data on initial operation, wiring diagrams, performance curves, engineering data and tests, operating procedures, routine maintenance procedures, and parts lists for each item of electrical equipment installed under this contract and submit all manufacturer's guarantees and warranties.

C. Shop Drawings: The Contractor shall furnish shop drawing portfolios and proper transmittal forms for all materials, equipment, and lighting fixtures to be incorporated in the work in accordance with the General Conditions, Supplementary Conditions, and all other applicable Conditions.

1. Shop drawings on component items forming a system or that are interrelated shall be submitted at one time as a single submittal in order to demonstrate that the items have been properly coordinated and will function properly as a system. A notation shall be made on each shop drawing submitted as to the item's specific use, either by a particular type number referenced on the drawings or in the specifications, by a reference to the applicable paragraph of the specifications, or by a description of its specific location. The shop drawings shall be organized and bound into sets with each set collated.
2. The Engineer shall have the final authority as to whether the equipment or material submitted is equal to the specified item. Proposed substitutions may be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item.

3.3 EXISTING UTILITIES

A. The Contractor shall verify the location of all existing utilities with the Owner and Utility providers prior to commencing excavation work. In addition, the contractor is responsible for locating and maintaining all existing utilities without damage. Fully coordinate all new underground utility work with existing utilities on the site The drawings and survey data of the contract documents indicate the available information on the existing power and communication services, and on new services to be provided to the project by utility provider. Accuracy of this information is not assured.

3.4 ELECTRICAL SERVICE

A. The Contractor shall provide all material and pay all fees required by the local utility provider for the connection of the new electrical service as shown on the plans. The Contractor shall also meet all equipment requirements of the local utility provider. The Contractor shall provide all necessary materials for construction of the temporary electrical service and shall coordinate all details with the local utility provider.

3.5 SMOKE AND SMOKE/FIRE DAMPERS

Provide all necessary duct detectors for smoke and smoke/fire dampers. In addition, provide all necessary connections, including power supply circuits (fed from the nearest panelboard, emergency if available, of the appropriate voltage unless indicated otherwise on the drawings) to smoke dampers and smoke/fire dampers so that upon fire alarm conditions or integral smoke detector activation, the dampers close. Coordinate damper and control locations with the mechanical and controls contractors. Refer to the mechanical drawings for damper schedule and locations.

3.6 ELECTRICAL-MECHANICAL EXTENT OF WORK

A. The responsibility of work specified under Divisions 21, 22, 23 and 26 is clarified under, Sections 21 05 00, 22 05 00 and 23 05 00. Said Sections are incorporated herein by reference.

3.7 ELECTRICAL PRODUCT COORDINATION

A. Refer to Division 2 through Division 32 and the electrical drawings for the power characteristics required and available for the operation of each power-consuming item of equipment. Coordinate purchases to ensure uniform interface with every item requiring electrical power.

3.8 CUTTING AND PATCHING

A. The Electrical Contractor shall be responsible for all cutting and patching of holes in building construction which are required for the passage of electrical work. Cutting and patching shall conform to the requirements of Division 1 and, if applicable, Division 2 of these specifications.

B. Cutting of structural framing, walls, floors, decks and other members intended to withstand stress is not permitted.

3.9 PAINTING, FINISHING

A. Painting of electrical work exposed in occupied spaces, except mechanical and electrical machine rooms and maintenance/service spaces; and work exposed on the exterior of the facility is specified and performed under other divisions of these specifications.

B. Factory finishes, shop priming, and special protective coatings are specified in the individual equipment specification sections.

C. Where factory finishes are provided on equipment and no additional field painting is specified, all marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish at the time of final inspection.

3.10 EXCAVATION AND BACKFILLING

A. Contractor shall perform all excavation and backfilling necessary to install the required electrical work. Coordinate the work with other excavating and backfilling work in the same area. Except as indicated otherwise, comply with the applicable sections in Division 31 of these specifications, excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.

B. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Contractor.

3.11 CONDUITS AND SUPPORT, GENERALLY

A. Conduits, except electrical conduits run in floor construction, shall be run parallel with or perpendicular to lines of the building unless otherwise noted on the drawings. Electrical conduits shall not be hung on hangers with any other service, unless specifically approved by the Engineer. Electrical conduits shall be hung above all other service pipes. Hangers on different service lines running close to and parallel with each other shall be in line with each other and parallel with, or perpendicular to, the lines of the building. Exact location of electric outlets, piping, ducts, and the like shall be coordinated to avoid interferences between lighting fixtures, piping, ducts, and similar items.

3.12 ACCESS PANELS

A. Furnish and install panels for access to junction boxes and similar items where no other means of access, such as a readily removable, sectional ceiling is shown or specified.

B. Panels shall not be less than 12-inches by 16-inches in size. Larger panels shall be furnished where required. Panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

1. Refer to Section 08 31 13 – Access Doors and Panels for specific information on type and size of panels

3.13 INSTALLATION OF EQUIPMENT

A. Install and connect all appliances and equipment as specified and indicated for this project, in accordance with the manufacturers' instructions and recommendations. Furnish and install complete electric connections and devices as recommended by the manufacturer or required for proper operation.

3.14 ELECTRICAL DEMOLITION

A. Refer to Division 01 Sections for general demolition requirements and procedures.

B. Refer to the drawings for additional demolition requirements.

C. Disconnect, demolish, and remove electrical systems, equipment and components specified under Divisions 26, 27 & 28 and as indicated on the drawings.

1. For conductors serving devices shown to be removed: Disconnect the device and remove all conduit and conductors back to the panel or to the next device shown to remain or as required by actual circuiting.
2. Coordinate all phasing and related electrical system outages with the Owner and all other disciplines.
3. For mechanical equipment indicated shown to be removed on either the mechanical and/or the electrical plans: Disconnect the equipment and remove all conduit, conductors and associated electrical supply equipment. Remove conduit and conductors back to the panel or the next device shown to remain or as required by actual circuiting.

3.15 COORDINATION

A. Coordinate the electrical work with work of the different trades so that:

1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
2. Within the limits indicated on the drawings, the maximum practicable space for operation, repair, removal and testing of electrical and other equipment will be provided.
3. Pipe, conduits, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, conduits, ducts, and

similar items shall be located so that they will not interfere with the intended use of other equipment.

B. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

C. Any work installed prior to approval of coordination drawings shall be at the Contractor's risk. Subsequent relocations required to avoid interference's shall be made without additional expense to the Owner.

3.16 SINGULAR NUMBER

A. Where any device or part of equipment is herein referred to in the singular number (such as "the switch"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

3.17 WARRANTY

A. Refer to the General Conditions section of this Specification for warranty requirements and information.

3.18 CLOSE OUT AND OPERATION INSTRUCTIONS

A. Sequence operations properly so that all work of this project will not be damaged or endangered. Operate each item of equipment and each system in a test run of appropriate duration to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.

B. Conduct a full-day walk-through instruction seminar for the Owner's personnel to be involved in the continued operation and maintenance of electrical equipment and systems. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, security, safety, efficiency and similar features of the systems.

C. At the time of substantial project completion, turn over the prime responsibility for operation of the electrical equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.

SUBSTITUTIONS

D. All proposals shall be based on providing and installing the materials or items of equipment which are hereinafter specified by name and/or manufacturer. Substitutions, for materials or items of equipment specified, will not be allowed, unless approved by Engineer prior to (10 days before) bid date.

E. Refer to Instructions to Bidders for complete requirements for substitutions.

3.19 AS-BUILT DRAWINGS

A. Contractor shall provide the Owner with as-built drawings for all electrical systems as described in these specifications and/or shown on the Drawings.

END OF SECTION 26 05 00

MOTOR TEST REPORT

DATE:_____
SHEET NO. _____ OF _____

PROJECT NAME: _____
PROJECT NUMBER:_____

DESIGNATION						
LOCATION						
HORSEPOWER						
NEMA STARTER SIZE						
MAXIMUM HEATER AMPS						
MEASURED CONDITIONS	PHASE			PHASE		
	A	**B**	**C**	**A**	**B**	**C**
ACTUAL MOTOR CURRENT						
NAMEPLATE MOTOR CURRENT						
NO LOAD VOLTAGE						
FULL LOAD VOLTAGE						

DESIGNATION						
LOCATION						
HORSEPOWER						
NEMA STARTER SIZE						
MAX HEATER AMPS						
MEASURED CONDITIONS	PHASE			PHASE		
	A	**B**	**C**	**A**	**B**	**C**
ACTUAL MOTOR CURRENT						
NAMEPLATE MOTOR CURRENT						
NO LOAD VOLTAGE						
FULL LOAD VOLTAGE						

ELECTRICAL TEST REPORT

DATE:_____
SHEET NO. _____ OF _____

PROJECT NAME: _____
PROJECT NUMBER:_____

SERVICE TRANSFORMER SIZE	
NO LOAD SERVICE VOLTAGE	
FULL LOAD SERVICE VOLTAGE	

DESIGNATION									
LOCATION									
MEASURED CONDITIONS	PHASE			PHASE			PHASE		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
NO LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER CURRENT									

DESIGNATION									
LOCATION									
MEASURED CONDITIONS	PHASE			PHASE			PHASE		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
NO LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER CURRENT									

SECTION 26 05 01- BASIC MATERIALS AND METHODS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. The extent of Basic Materials and Methods is indicated by the drawings and specifications. Basic materials are defined but not limited to cable and conduit seals, outlet boxes, pull boxes, conduit fittings, safety switches, and fuses.

1.3 QUALITY ASSURANCE

A. Manufacturers: All materials shall be new, unused, and unweathered, and of the quality specified. Materials shall be standard products of manufacturer's regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design.

B. Installer: All equipment and materials shall be installed in a neat and workmanlike manner, shall be complete in both effectiveness and appearance, whether finally concealed or exposed and shall be executed by experienced mechanics.

1.4 REFERENCES

A. The electrical work shall conform to all applicable sections of standards, codes and specifications promulgated by organizations listed below.

1. Occupational Safety and Health Standard, National Consensus Standards and Established Federal Standards
2. National Electrical Code (NEC)
3. National Electric Manufacturer's Association (NEMA)
4. American Society for Testing of Materials (ASTM)
5. Underwriters Laboratories, Inc. Standards (UL)
6. Factory Mutual Engineering Corporation or other Recognized National Laboratories

1.5 SUBMITTALS

A. Shop drawings: Prepare a set of shop drawings showing manufacturers product data for all component parts specified in this Section.

2. PRODUCTS

2.1 Equipment and Materials Furnished by Others: Certain materials and equipment for this project will be furnished under other divisions. These materials and equipment, which are shown or noted on the plans, will be installed and/or connected under this Division. It shall be incumbent upon this Contractor to become familiar with all of the materials and equipment that will be furnished under other Divisions, but which will be installed and/or connected under this Division.

2.2 Cable and Conduit Seals: Seals shall be provided around all conduits and cables which penetrate smoke walls, fire walls, and floors. Nelson Flameseal System shall be used to seal penetrations of electrical cables and conduits.

A. Materials used shall be flameseal putty, ceramic fiber insulation and where rigid support on large oversized openings is required, ceramic fiber board. Board shall be rigid and able to withstand temperatures in excess of 2000 degrees F.

B. Accessory hardware shall be provided as required on oversized openings.

C. Follow manufacturers instructions in selecting the type of seals and accessories. Also follow the manufacturers instructions on installation of the cable and conduit seals. Equal quality equipment by OZ Gedney and 3M shall be acceptable.

2.3 **Animal Area Sealants: All penetrations into animal area and containment area environments, including all conduits, cables, boxes, electrical devices, etc. shall be adequately sealed to maintain the environment. ASTM C920 compliant sealing and caulking compound shall be used to seal around all raceway, cable and box penetrations through Animal Area walls, ceilings and floors. Provide 100% silicone sealant between all surface mounted electrical devices and finished walls and ceilings within the Animal Area. Provide 100% silicone sealant between flush mounted electrical device faceplates and finished walls and ceilings within the Animal Area. For recessed lighting, provide non-halogenated latex-based elastomeric sealant along the perimeter of the lighting fixture housings where the housing of the fixture penetrates the animal area ceiling. For surface mounted lighting, provide non-halogenated latex-based elastomeric sealant along perimeter of fixture where fixture housing meets the animal area finished ceiling. Reference electrical details for additional sealant and caulking information.**

2.4 Outlet Boxes, Pull Boxes and Conduit Fittings: Furnish and install outlet boxes, pull boxes, and conduit fittings as described below. Catalog numbers shown are Appleton Electric Company; Steel City, O.Z. Gedney, and Raco, are equally acceptable.

A. OUTLET BOXES

1.	Lighting Boxes (concealed)	No. 40-3/4
2.	Lighting Boxes (concrete)	OCR Series

3.	Lighting Boxes (exposed)	4S-3/4 or 40-3/4
4.	Flush Switches, Receptacles and Flush Junction Boxes	No. 4S-3/4 with separate extension plaster ring; M*-250 in masonry construction (* refers to number of devices in the box)
5.	Weatherproof type Switch, Receptacle and Telecommunications Boxes (exposed) and **all devices installed within the Animal Area.**	FD Series w/FD cover and neoprene gasket.
6.	Switch, Receptacle and Telecommunications Boxes (exposed)	4S-3/4 with 8360 or 8370 series raised surface cover.

7. Telecommunications Boxes

   a. At minimum, the typical communications backbox shall be 4-11/16-inch square by 2-1/8- inch deep with 1-1/4-inch knockouts and a 4-11/16-inch square mud ring for one (1) device (single-gang) unless noted otherwise.

   b. For flush mounted boxes, Manufacturer shall be:

      1) RACO/Hubbell Electrical Products – 4-11/16-inch Square Box, 2-1/8-inch Deep, 1-1/4-inch Side Knockouts. (P/N RACO259) with 4-11/16-inch square mud ring for one (1) device (verify appropriate Mud-Ring depth).
      2) Randl Industries, Inc. – 5-square Telecommunications Outlet Box (P/N T55017) with appropriate single gang mud ring.
      3) Or approved equivalent.

   c. For outlets in CMU wall, submit appropriate backbox for application.
   d. For outlets above ceiling for applications such as Wireless Access Points

      1) RACO/Hubbell Single-gang Galvanized Steel Box (P/N 2DDB6)
      2) Or approved equivalent.

B. Extension and plaster rings shall be installed as required by the NEC.

C. Outlet boxes shall comply with the National Electrical Code in regard to the allowable fill.

2.5 PULL BOXES

A. Pull boxes shall be fabricated of code gauge galvanized sheet metal and shall be sized in accordance with the National Electrical Code requirements or as shown on the drawings. Provide removable cover on the largest access side of the box. In-line conduit pull boxes may

be O.Z., Type PBW, or equal. Provide pull boxes at all code required locations, and as needed to aid in cable pulling.

2.6 SAFETY SWITCHES

A. Furnish and install heavy duty type safety switches, having the electrical characteristics, ratings and modifications shown on the drawings. All switches shall have:

B. NEMA 1 general purpose enclosures unless otherwise noted for all interior applications;

C. NEMA 3R rainproof enclosures unless otherwise noted for all exterior applications and in all mechanical rooms;

D. NEMA 4/4X stainless steel enclosures unless otherwise noted in all animal areas.

E. Fully rated neutral assemblies;

F. Equipment grounding kits;

G. Metal nameplates, front cover mounted that contain a permanent record of switch type, catalog number and H.P. ratings with both standard and time delay fuses;

H. Handle that is padlockable in "OFF" position;

I. Non-teasible, positive quick-make, quick-break mechanism;

J. UL approval and shall bear the UL label;

K. All fusible switches shall have Class R Fuse rejection clips.

L. Safety switches, as manufactured by the following, will be equally acceptable, but all safety switches furnished by this Contractor shall be the product of one manufacturer:

1. Square D Company
2. General Electric
3. Cutler Hammer
4. Siemens

2.7 FUSES

A. Fuses shall be furnished and installed in each fused switch, and shall be rated as shown on the drawings.

B. Provide fuses according to the following and in accordance with recommendations of manufacturers whose equipment is being protected:

1. Provide UL Class L current limiting time-delay fuses rated 600-volts, 60 Hz, 601 to 6000 amps, with 200,000A RMS symmetrical interrupting current rating for protecting transformers, motors and circuit breakers. (Similar to Buss Low-Peak fuses.)
2. Provide UL Class L current limiting fast-acting fuses rated 600-volts, 60 Hz, 601 to 6000 amps, with 200,000A RMS symmetrical interrupting current rating for protecting service entrances and main feeder circuit breakers. (Similar to Buss Limitron fuses.)
3. Provide UL Class RK1 current limiting, dual-element, time-delay fuses rated 600-volts, 60 Hz, 1/10 to 600 amps, with 200,000A RMS symmetrical interrupting current rating for protecting motors and circuit breakers. (Similar to Buss Low-Peak fuses.)
4. Provide UL Class RK1 current-limiting fuses rated 250-volts, 60 Hz, 1/10 to 600 amps, with 200,000A RMS symmetrical interrupting current for protecting motors and circuit breakers. (Similar to Buss Low-Peak fuses.)
5. Provide UL Class J current-limiting fuses rated 600-volts, 60 Hz, 1 to 600 amps, with 200,000A RMS symmetrical interrupting current rating for protecting circuits with no heavy inrush current where reduced dimension devices are required.
6. Provide UL Class H fuses rated 600-volts, 60 Hz, 1/10 to 600 amps, with 10,000A RMS symmetrical interrupting current rating for protecting general purpose light duty feeders.
7. Provide UL Class T fuses rated 600-volts, 60 Hz, 1 to 1,200 amps, with 200,000A RMS symmetrical interrupting current rating for protection of non-motor loads where reduced dimension devices are required.

C. Three spare fuses shall be furnished for each size and type used. Each fused switch shall be provided with a mastic backed label clearly identifying the type and size of fuse required.

3. EXECUTION

3.1 PRODUCT INSTALLATION, GENERAL

A. Except where more stringent requirements are indicated, comply with product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing.

3.2 MOUNTING HEIGHTS

A. Mounting heights to the center of the box above finished floor for the items listed below shall be as follows, unless otherwise shown. All other device mounting heights shall be as shown on the drawings. All devices shall be mounted in accordance with ADA (Americans with Disabilities Act) requirements.

B. Flush tumbler switches and lighting controls 46"

C. Switches in concrete block 46"

D.	Switches over wainscot	6" above 48" wainscot
E.	Convenience outlets	18" mounted vertically with ground prong slot at bottom
F.	Safety switches	54"
G.	Motor controllers	54"
H.	Panelboards to top	72"
I.	Telecommunications outlets	18"
J.	Telecommunications outlets (pay and wall type)	54" for non-ADA type 44" for ADA type
K.	Clock outlets 8' ceiling 9' ceiling	84" 96"
L.	Receptacles above counters	8" above counters mounted vertically
M.	Convenience outlets in mechanical, electrical, telecommunications, janitor and elevator machine rooms	48”
N.	Exterior W.P. convenience outlets	24" above grade mounted
O.	Fire alarm pull station	46"
P.	Fire alarm horn, speaker, bell chime And/or strobe	84"
Q.	Intercom System Pushbutton Stations	46"
R.	Card Readers	46”

S. Contractor shall check all equipment layouts and verify exact mounting heights.

3.3 CUTTING AND PATCHING FLOORS, WALLS OR CEILINGS

A. Cutting, patching, repairing, and finishing of carpentry work, metal work, or concrete work, etc., which may be required for this work shall be done by craftsmen skilled in their respective trades. When cutting is required, it shall be done in such a manner as not to weaken walls, partitions, or floors. Holes required to be cut in floors must be drilled without breaking out around the holes. Cutting, patching, and painting shall conform to the requirements of the General Conditions section of this Specification.

B. Cutting of structural framing, walls, floors, decks, or other members intended to withstand stress is not permitted.

C. Sleeves through floors or walls shall be black iron pipe and shall be flush with finished faces of floors, walls or ceilings. Sleeves shall be sized to accommodate raceways indicated.

D. Use care in piercing water proofing. After the part piercing the waterproofing has been set in place, seal openings, and make absolutely watertight.

3.4 SLEEVES

A. Sleeves shall be used to accommodate conduit or tubing where conduit or tubing pass through newly poured concrete walls or slabs.

B. All sleeves through floors and walls shall be black iron pipe, flush with walls or finished floors; and of sizes to accommodate the raceways shown. Sleeves through outside walls above grade shall be caulked with approved caulking compound. Sleeves shall not be required through on grade slabs.

C. For raceways which enter buildings below grade, install manufactured floor and thruwall seals, similar to Type "FSK" or "WSK" as manufactured by O.Z. Electric Manufacturing Co.

D. For raceways that penetrate into the animal area, provide gas-tight and water-tight penetrations to maintain the integrity of the environment.

3.5 INSTALLATION METHODS

A. Conductors shall be installed in concealed raceways except as shown otherwise on the drawings or specified to be otherwise in these specifications. Exposed conduits and wires shall be installed parallel or perpendicular to building surfaces. Conduits and wires in the space above ceilings shall be supported adequately and shall not be laid on the top of ceiling systems. Conduits and wires installed above ceilings shall be considered exposed.

B. Electrical conduits shall not be hung on hangers with any other service foreign to the electrical systems, nor shall they be attached to other foreign services.

C. The lighting and power branch circuit conductors shall be installed in separate raceway systems unless specifically shown or noted otherwise.

D. Equipment Bases. Provide concrete equipment bases for all floor mounted equipment furnished under this contract. Concrete bases shall be 3-1/2"-inches high unless noted otherwise and shall extend 3-inches beyond all sides of the unit. Trowel all edges at a 45 degree angle. This work shall be done in accordance with Division 3 of the specifications by the Division 26 Contractor. Bases shall be provided for switchboards, motor control centers, transformers and all other floor mounted equipment.

E. Outlet Box Locations. Outlet boxes shall be located so they are not placed back-to-back in the same wall, and in metal stud walls, are separated by at least one stud space in order to limit sound transmission from room to room. Outlet boxes installed on opposite sides of fire rated walls shall be spaced at least 24" apart.

3.6 WIRING - NUMBER OF WIRES REQUIRED

A. The number of wires for lighting and receptacle branch circuits is shown on the drawings. The number of wires in any circuit is determined in accordance with the National Electrical Code, and wiring is provided to perform all functions of the devices being installed. Additionally, wires shall be provided as required by the contract documents, i.e. equipment grounds, etc. Provide the number of wires required for a complete and workable system.

3.7 PROTECTION FROM WEATHER

A. Raceway stub ups shall be capped or otherwise protected from moisture and debris until such time that the conductors are pulled. Conductors shall not be installed in raceways until the building is protected from the weather, all concrete and plastering is completed, and raceways in which moisture has collected have been swabbed or blown out.

3.8 ELECTRICAL ROOM COORDINATION

A. Where a number of electrical panels and/or related electrical items are shown, the Electrical Contractor shall coordinate the physical sizes with his equipment suppliers to ensure that there is adequate space for the items shown to be installed in those areas and that all Code required clearances are maintained.

B. The Contractor shall rearrange the equipment layout to achieve full use of the available space prior to installing conduit stub ups. Where a conflict or rearrangement exists, the Contractor shall submit a proposed revised layout of the area to the Engineer.

3.9 NAMEPLATES

A. Nameplates shall be provided for all items such as panelboards, cabinets, motor controllers (starters), safety switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards and motor control centers, control devices and other significant equipment

B. Nameplates shall be 1"x 2-1/2" laminated phenolic resin (white background, black lettering) with engraved lettering, a minimum of 1/4-inch for grouped equipment/loads and minimum 1/8" high for individual equipment/loads. Manufacturers factory installed nameplates shall be acceptable provided all information is furnished.

C. Nameplates shall identify the equipment item that the device is serving and also from where the device is being fed from. Nameplates shall also identify the system voltage of the item of equipment.

D. Nameplates shall also be provided listing calculated SCCR at the main service distribution equipment and elevator controllers in accordance with NEC requirements.

E. Branch panelboards nameplates shall include name of panel in which it is served from.

F. All concealed junction boxes serving fire alarm devices shall be colored red and labeled "Fire Alarm" with a nameplate as described above.

3.10 RACEWAY SUPPORTS

A. Raceways shall be securely supported and fastened in place with pipe straps, wall brackets, caddy clips, hangers or trapeze hangers at intervals specified in Section 26 05 33 "RACEWAYS" or:

1. As shown on the drawings.

2. As may be required by special adverse field conditions.

B. Spring tension clamps on building steel work may be used only by special permission.

C. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws or welded threaded studs on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine wood screws. Threaded C-clamps shall not be used. Raceways or pipe straps shall not be welded to steel structures. Holes cut in reinforced concrete beams or in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled. In partitions of light steel construction, sheet-metal screws may be used, and bar hangers may be attached with saddle ties of not less than No. 16 AWG double strand zinc-coated steel wire. No raceway shall be attached to the suspended ceiling construction. Conduits shall be fastened to all sheet-metal boxes and cabinets with two locknuts and insulating bushings.

3.11 BOX SUPPORTS

A. Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and expansion shields on concrete or brick, with toggle bolts on

hollow masonry units, and with machine screws or welded studs on steel work. Plastic expansion shields shall not be used. Threaded studs driven in by powder charge and provided with lockwashers and nuts may be used in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces, cast metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Raceways shall be supported with an approved type fastener not more than 24-inches from the box. Penetration into reinforced concrete beams and into reinforced-concrete joists shall avoid cutting any main reinforcing steel.

3.12 LIGHTING FIXTURE SUPPORTS

A. Lighting fixtures shall be supported as follows and in accordance with all applicable Codes and Regulations:

1. By fixture studs or other devices securely attached to outlet box, or;
2. By special hangers designed and intended for use as lighting fixture supports, or;
3. By a special clip or device attached to the ceiling system grid designed to secure the lighting fixture in place or;
4. By other methods and devices designed and intended for use as lighting fixture support, or;
5. As shown on the drawings.
6. All lighting fixtures installed in grid type suspended ceiling systems, shall be positively attached to the ceiling system with clips that are UL listed for the application. In addition, a minimum of four (4) ceiling support system rods or wires shall be provided for each light fixture and shall be installed not more than six (6) inches from fixture corners. Provide two (2) No. 9 gage hangers from each fixture housing to the building structure above (wires may be installed slack). Light fixtures that weigh more than 56 pounds shall be supported directly from the structure above by UL listed and approved hangers. Light fixtures that are smaller than the ceiling grid shall be installed at locations indicated on the reflected ceiling plans, or shall be installed in the center of the ceiling panel and shall be supported independently by at least two metal channels that span and are secured to the ceiling system.
7. Suspended lighting fixtures shall be supported directly from the building structure without using suspended ceilings as support systems. Support systems shall be UL listed and approved for the specific installation. Where pendants or rods exceed 48 inches in length, brace support systems to limit swinging.

B. The lighting fixture support system detail shall be submitted with and be a part of the lighting fixture shop drawing submittal.

C. Lighting fixtures shall <u>not</u> be supported from the leg of pre-cast pre-stressed concrete.

END OF SECTION 26 05 01

SECTION 26 05 19 - CONDUCTORS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work in this Section.

B. This Section is a Division 26 "Basic Materials and Methods" section, and is part of each Division 26 section making reference to conductors.

1.2 Description of Work: Extent of electrical wire and electrical cable work is indicated by drawings and schedules. Types of wire, cable and connectors in this Section include the following:

A. Conductors

B. Power-limited circuit cable

C. Service entrance cable

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of electric wire and cable products of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical wiring work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wire, cable and connectors.

B. UL Compliance: Comply with UL standards pertaining to wire cable and connectors.

C. UL Labels: Provide electrical wires, cables and connectors which have been UL-listed and labeled.

D. NEMA/ICEA Compliance: Comply with applicable portions of NEMA/Insulated Cable Engineers Association Standards pertaining to materials, construction and testing of wire and cable.

E. ANSI/ASTM: Comply with applicable portions of ANSI/ASTM standards pertaining to construction of wire and cable.

F. IEEE Compliance: Comply with applicable portions of IEEE standards pertaining to wire and cable.

G. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

A. Submit manufacturer's data on electric wire and cable.

2. PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of wire, cable and connector):

A. WIRE AND CABLE:

1. Advance Wire and Cable, Inc.
2. Cerro Wire and Cable, Co.
3. Electrical Conductors, Inc.
4. General Cable Corp.
5. Hitemp Wires, Inc.
6. Rome Cable Corp.
7. Southwire Company
8. The Okonite Company
9. Encore Wire

B. CONNECTORS:

1. Amp, Inc.
2. Burndy Corp.
3. Eagle Electric Mfg. Co., Inc.
4. Gould, Inc.
5. Ideal Industries, Inc.
6. Josylyn Mfg. and Supply Co.
7. O-Z/Gedney Co.
8. Pyle National Co.
9. Thomas and Betts Co.

2.2 WIRE, CABLE, AND CONNECTORS

A. General: Except as otherwise indicated, provide wire, cable and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, and as required for the installation.

B. WIRE:

1. All conductors shall be 600-volt and shall be copper, soft drawn, annealed, having a conductivity of not less than 98% pure copper with dual rated type THHN/THWN insulation unless otherwise specified or indicated on the drawings.
2. No wire shall be smaller than No. 12 AWG, except wiring for signal and pilot control circuits, and pre-manufactured fixture whips for light fixtures.
3. All wire No. 10 AWG and smaller shall be solid unless otherwise indicated within these specifications. All wire No. 8 AWG and larger shall be stranded.
4. All wiring installed in light poles or other areas subject to vibration shall be stranded.
5. Wire sizes shown are minimum based on code requirements, voltage drop and/or other considerations. Larger sizes may be installed at the Contractor's option to utilize stock size, provided conduit sizes are increased where necessary to conform to the National Electrical Code. Sizes of wires and cables indicated or specified are American Wire Gage (Brown and Sharpe).
6. All feeder and branch circuit wiring shall be color-coded as follows:

PHASE	120/208 VOLT	277/480 VOLT
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	*White	*White
Ground	Green	Green

*Except as provided in paragraph 200.6 of the NEC.

C. ALUMINUM WIRE:

1. Aluminum conductors shall not be substituted for copper conductors.

D. CONNECTIONS

1. Wire connections shall be as follows unless otherwise indicated on the drawings.

   a. Use preinsulated connectors 3M Company "Scotchlok," or Ideal Industries, Inc. "super nut," for splices and taps in conductors No. 10 AWG and smaller. All other twist-on connectors must be reviewed by the Architect prior to installation. Use this type of connector for factory-made splices in fixtures or equipment.
   b. Pressure indent type connectors must be submitted to the Architect for review.
   c. Tape all splices and joints with vinyl plastic tape manufactured by Minnesota Mining and Manufacturing Company. Use sufficient tape to secure insulation strength equal to that of the conductors joined.

d. Keep splices in underground junction boxes to an absolute minimum. Where splices are necessary, use resin pressure splices and resin splicing kits manufactured by the 3M Company, St. Paul, Minnesota, to totally encapsulate the splice. Arrange the splicing kit to minimize the effects of moisture.

e. Connect wire No. 6 AWG and larger to panels and apparatus by means of approved lugs or connectors.

f. Connect wire No. 10 AWG and larger to panels, motors and electrical apparatus using OZ (or equivalent) type XL set screw type lugs. Lugs shall accommodate full wire capacity for stranded conductors. All connections and connectors shall be solderless.

g. Connectors of the porcelain cup type with or without metal inserts shall not be used, including all splices in fixtures which are made in advance by the fixture manufacturer. Splices in wire No. 8 AWG and larger shall be made with approved solderless lugs. If any type of pressure indent type connector is proposed for use on any size conductor, it shall be specifically submitted for approval prior to use.

3. EXECUTION

3.1 INSTALLATION

A. General: Install electric cables, wires and connectors as indicated in compliance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices.

B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

C. Conductors shall be continuous from outlet to outlet and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized wherever required.

D. Splicing: No splicing or joints will be permitted in either feeder or branch circuits except at outlet or accessible junction boxes.

E. Wire shall not be installed in raceways until the concrete work and plastering is completed and all conduits in which moisture has collected have been swabbed out. Insulation resistance to ground shall not be less than that approved by NEC. Eliminate splices wherever possible.

F. Use pulling compound or lubricant where necessary. Compound must not deteriorate conductor insulation.

G. Prior to energization, check cable and wire for continuity of circuitry, and for short circuits. Correct malfunctions when detected.

H. Bury a continuous, pre-printed, bright colored plastic ribbon cable marker with each underground cable, regardless of whether conductors are in conduit. Locate each directly over cables 12" below finished grade.

I. Conductor Installation: Install all conductors in a single raceway at one time, insuring that conductors do not cross one another while being pulled into raceway. Leave sufficient cable at all fittings or boxes and prevent conductor kinks. Keep all conductors within the allowable tension and exceeding the minimum bending radius.

J. Conductor Support: Provide conductor supports as required by the code and recommended by the cable manufacturer. Where required, provide cable supports in vertical conduits similar to OZ Type C.M.T., and provide the lower end of conduit with OZ Type KVF ventilators.

K. Conductor Termination: Provide all power and control conductors, that terminate on equipment or terminal strips, with solderless lugs or fork and flanged tongue terminals. Provide T and B "sta-kon" tongue terminal. This type conductor termination is not required when the equipment is provided with solderless connectors.

L. Provide dedicated neutral conductors for all branch circuits. Neutral conductors shall not be shared between circuits.

3.2 CONDUCTOR ARCPROOFING

A. Cover two or more power feeder cables occurring in the same switchboard section, junction box or pull box (including pull boxes over switchboards) with arcproof and flameproof tape.

B. Provide 3M Company "Scotch" No. 77 tape or Plymouth Rubber Co. Slipknot No. 30 tape, to provide an installation capable of withstanding a 200-amp arc for not less than 30 seconds.

C. Apply tape in a single layer, one-half lapped, or as recommended by the manufacturer to conform to the above requirements. Apply with the coated side next to the cable and hold in place with a random wrap of 1/2 inch wide, pressure-sensitive, glass cloth electrical tape, 3M Company "Scotch" No. 69. Tape to be color coded as specified previously.

END OF SECTION 26 05 19

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 26 - GROUNDING SYSTEM

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

B. Division 26 "Basic Materials and Methods" sections apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Extent of grounding work is indicated by the drawings and is specified herein.

B. Applications of grounding work in this Section include the following:

1. Underground Metal Piping
2. Underground Metal Water Piping
3. Metal Building Frames
4. Ground Rods
5. Separately Derived Systems
6. Service Equipment
7. Enclosures
8. Equipment

C. Requirements of this Section apply to electrical grounding work specified elsewhere in these specifications.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings, of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been of satisfactory use in similar service for not less than three years.

B. Installer: Qualified with at least three (3) years experience on projects with electrical grounding work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL listed and labeled.

B. UL Compliance: Comply with applicable requirements of UL Standard Nos. 467 and 869 pertaining to electrical grounding and bonding.

C. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

D. Utility: Grounding shall be done so as to comply with all applicable grounding requirements and rules of the serving utility.

E. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

A. Product Data: Submit manufacturers data on grounding systems and accessories.

B. Shop Drawings: Submit layout drawings of grounding systems and accessories including, but not limited to, ground wiring, copper braid and bus, and ground rods.

2. PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with the requirements, provide grounding products of one of the following:

A. B-Line Systems

B. Burndy Corporation

C. Crouse Hinds

D. Electrical Components Div.; Gould Inc.

E. General Electric Supply Co.

F. Ideal Industries, Inc.

G. Thomas and Betts Corp.

H. Western Electric Co.

2.2 Grounding Systems: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including but not limited to cables/wires, connectors, terminals, ground rods/electrodes, bonding jumper braid, and additional accessories needed for a complete installation. Where more than one type unit meets indicated requirements, selection

is installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE and established industry standards for applications indicated.

2.3 Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC requirements.

2.4 Bonding Jumper Braid: Provide copper braid tape, constructed of 30 gage bare copper wires and properly sized for indicated applications.

2.5 Flexible Jumper Strap: Provide flexible flat conductor, 480 strands of 30 gage bare copper wire; 3/4" wide, 9-1/2" long; 48,250 cmil. Protect braid with copper bolt hole ends with hole sized for 3/8" dia. bolts.

2.6 Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.

2.7 Ground Rods: Provide steel ground rods with copper welded exterior, 3/4" dia. x 10'.

2.8 Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by accessories manufacturers for types of service indicated.

3. EXECUTION

3.1 GENERAL

A. Inspection: Installer must examine areas and conditions under which electrical grounding connections are to be made and notify the Architect/Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

B. General: Install electrical ground systems where shown, in accordance with applicable portions of the NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

C. Coordinate with other electrical work as necessary to interface installation of electrical grounding systems with other work.

D. Grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded shall be accomplished for temporary and permanent construction.

E. Provide a separate green equipment ground conductor in all electrical raceways to effectively ground all fixtures, panels, receptacles, controls, motors, disconnect switches, exterior lighting

standards and noncurrent carrying metal enclosures. The ground wires shall be connected to the building system ground. NEC Table 250.122 shall be used to size the ground conductor if the size is not shown on the drawings.

F. To satisfy the "effective grounding" requirements of the NEC the path to ground from circuits, equipment, and conductor enclosures shall be permanent and continuous and shall have ample carrying capacity to conduct safely any currents liable to be imposed on it, and shall have impedance sufficiently low to limit the potential above ground and to facilitate the operation of the overcurrent devices in the circuit.

G. Building columns, roof steel, and footer steel reinforcing shall be electrically continuous.

H. Ground the service in accordance with provisions of the National Electrical Code and the contract drawings.

I. Clean the contact surfaces of all ground connections.

J. Where separately derived systems occur, ground the system to a grounding electrode acceptable to the code.

K. Provide equipotential plane and required bonding for all animal holding areas in the building. Equipotential plan shall meet all requirements as dictated in NEC Article 547.

L. An onsite meeting shall be held including electrical contractor, general contractor, concrete contractor, and design team once all equipotential plane bonding to structural rebar has been installed, but before concrete is poured. General contractor shall be responsible for coordinating and organizing such meeting.

M. Install metallic raceways mechanically and electrically secure at all joints and at all boxes, cabinets, fittings and equipment. At the point of electrical service entrance, bond all metallic raceways together, with a ground conductor, and connect to the system ground bus. Bond all boxes as specified for equipment.

N. Receptacles: Permanently connect the ground terminal on each receptacle to the green ground conductor.

O. Motors: Connect the ground conductor to the conduit with an approved grounding bushing, and to the metal frame with a bolted, solderless lug.

P. New rebar as a part of the building addition shall be bonded to any new structural steel via (1) 3/0 copper grounding conductor that is cadwelded to rebar at one end and structural steel at the other end. The rebar utilized for the bonding connection shall be a minimum #4 size rebar and at least 20' in length.

Q. New structural steel frame shall be bonded to the existing structural steel frame via (1) 3/0 copper grounding conductor cadwelded at both connection points. Provide slack length in the conductor connecting the two building steel frames together as when bonding steel framing across a building expansion joint.

END OF SECTION 26 05 26

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 33 - RACEWAYS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

B. This Section is a Division 26 "Basic Materials and Methods" section, and is part of each Division 26 section making reference to electrical raceways specified herein.

1.2 DESCRIPTION OF WORK

A. Extent of raceways is indicated by drawings and schedules.

B. Types of raceways in this Section include the following:

1. Electrical metallic tubing.
2. Flexible metal conduit.
3. Intermediate metal conduit.
4. Liquid-tight flexible metal conduit.
5. Rigid metal conduit.
6. Rigid nonmetallic conduit.
7. Surface metal raceways.

1.3 REFERENCES

A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL-listed and labeled. Each length of raceway shall bear the Underwriters Laboratories label.

C. NEC Compliance: Comply with NEC requirements which are applicable to the construction and installation of raceway systems.

D. NECA Compliance: Comply with NECA's "Standard of Installation".

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of raceway required.

2. PRODUCTS

2.1 STEEL CONDUIT

A. Steel Conduit: Rigid steel conduit, intermediate metal conduit and steel electrical metallic tubing shall be hot-dipped, galvanized or sheradized as manufactured by Youngstown Sheet and Tube Company, National Electric, General Electric, or equal.

B. Joints: Raintight non-insulated throat type compression fittings (connectors and couplings) shall be provided for electrical metallic tubing systems. All fittings shall be of the steel type with steel locknuts equal to Appleton 95 Series.

C. Expansion Joints: Provide expansion fittings, O.Z. Type AX with bonding jumper for rigid conduit and O.Z. Type TX with bonding jumper for electrical metallic tubing. Where embedded raceways cross building expansion joints, provide combination deflection/expansion fittings, O.Z. Type AXDX, or equal.

2.2 RIGID NON-METALLIC (PVC) CONDUIT

A. PVC (polyvinyl chloride) Conduit: Heavy wall rigid PVC conduit shall be composed of high impact PVC and shall conform to industry NEMA Standards and to Federal Specification WC-1094. Conduits shall be Carlon Schedule 40 type, Schedule 80 type, or approved equal.

2.3 FLEXIBLE METAL CONDUIT

A. Flexible metal conduit shall conform to UL1. It shall be formed from continuous length of spirally-wound, interlocked zinc-coated strip steel.

B. **Pre-wired armored cabling, types AC or MC are not allowed.**

2.4 LIQUID-TIGHT, FLEXIBLE METAL CONDUIT

A. Liquid-tight flexible metal conduit shall be constructed of a single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; and coated with an oil-resistant, liquid-tight thermoplastic jacket.

2.5 WIREWAYS

A. General: Provide electrical wireways of types, grades, sizes, weights (wall thicknesses), and number of channels for each type service indicated. Provide complete assembly of wireways including, but not necessarily limited to couplings, offsets, elbows, expansion joints, adapters,

hold down straps, end caps, and other components and accessories as needed for a complete system. Where types and grades are not indicated, provide proper selection as determined by the Installer to fulfill wiring requirements and comply with applicable provisions of NEC for electrical raceways.

B. Surface Metal Raceways: Provide surface metal raceways of sizes and channels indicated; in compliance with FS W-C-582. Construct of galvanized steel with snap-on covers, with 1/8" mounting screw knockouts in base approximately 8" o.c. Provide fittings indicated which match and mate with raceway. Finish with manufacturer's standard prime coating suitable for painting. Provide all necessary devices as shown on the drawings for a complete installation.

C. Manufacturers: Subject to compliance with requirements, provide surface metal raceways of one of the following:

1. B-Line Systems, Inc.
2. Midland-Ross Corporation
3. Power-Strut Division; Youngstown Sheet and Tube Company
4. Square D Company
5. Versa-Tech Corporation
6. Walker/Parkersburg Division; Textron, Inc.
7. Wiremold Company

3. EXECUTION

3.1 GENERAL

A. Install electric raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation" and complying with recognized industry practices.

B. Raceways embedded in earth below floor slabs shall be rigid steel conduit, intermediate metal conduit or rigid schedule 80 PVC conduit and shall be a minimum of 12” below the concrete slab. Conduit shall be provided with Schedule 80 conduit elbows when the raceway system exits the concrete topping or earth. No conduit shall be embedded in concrete.

C. Electrical metallic tubing shall not be embedded in concrete, installed in earth, or installed exposed to weather.

D. Rigid heavy wall Schedule 80 PVC conduit shall be installed in earth and concrete only.

E. Raceways in outside walls (excluding building perimeter) or in refrigerated areas shall be rigid steel conduit, or intermediate metal conduit.

F. Provide rigid steel conduit or intermediate metal conduit for exposed raceways from floor to eight feet above the floor in mechanical rooms and in areas designated on the plans.

G. Rigid galvanized steel conduit or galvanized intermediate metal conduit shall be used where conduit is exposed to weather.

H. Rigid galvanized steel or intermediate metal conduit and cast boxes with external hubs shall be used to serve electrical devices located in all animal area environments.

I. Conduits in hazardous locations shall conform to the National Electrical Code. Rigid galvanized steel conduit or intermediate metal conduit shall be used in hazardous locations. PVC conduit shall not be used in hazardous areas.

J. Rigid metal, intermediate metal, electric metallic tubing or PVC conduit where allowed in other section 3.1 paragraphs shall be used for feeders and branch circuits.

K. Flexible metal conduit may be used to connect light fixtures in accordance with NEC requirements but must be limited to a maximum of 6'-0" in length. "Daisy chaining" from fixture to fixture is not permitted. Provide flexible metal conduit for connections to motors, transformers, generators, and other equipment subject to vibration. Length of flexible conduit shall be a minimum of one foot for conduit diameters up to 1-1/2". A minimum of 3" of flexible conduit shall be added for every 1/2" increase in conduit diameter. Flexible metal conduit installation shall be kept to a minimum in connecting other electrical equipment items. Sealtight, flexible conduit shall be used where the flexible conduit may be subject to moist or humid atmosphere, corrosive atmosphere, subject to water spray and subject to dripping oil, grease or water. **Flexible metal conduits shall not be permitted for any other applications, unless specifically approved by the Owner**

L. Conduits shall be 3/4" diameter, minimum. Raceway sizes shown on the drawing are based on type THHN/THWN conductors.

M. Type Material: Except as noted otherwise all conduit shall be steel.

3.2 INSTALLATION

A. All raceways shall be installed concealed except where shown or noted otherwise.

B. At the Owner's option, concealed raceways may be routed below the slab. At the Contractor's option, concealed raceways may be installed in furred spaces above ceilings or behind walls. Raceways shall not be embedded in concrete slab.

C. Continuity: Provide metallic raceways continuous from outlet to outlet, and from outlets to cabinets, junction or pull boxes. Enter and secure conduit to all boxes to provide electrical continuity from the point of service to outlets. Provide double locknut and bushing on terminals of metallic conduits.

D. A nylon or polypropylene pull string shall be installed in all empty conduits to facilitate future installation of cabling.

E. Provide accessible "seal-off" fittings for all raceways entering or leaving the **animal facility area**, hazardous areas, and as otherwise required by the National Electrical Code.

F. Where conduits penetrate the roof seal, they shall be installed in curbs provided for mechanical equipment. When this is not possible, suitable pitch pockets, lead flashing, or approved fittings shall be provided. Details for special conduit installations shall be as shown on the drawings.

G. Reinforced Concrete: No reinforcing steel shall be displaced to accommodate the installation of raceways and outlet boxes. Outlet boxes shall not be installed in beams or joists. In general, all embedded conduits shall be located in the physical center of the particular section of concrete. Unless otherwise indicated, raceways embedded in reinforced concrete shall conform to the following usual types of conditions. Particular attention is called to the fact that there are many extenuating conditions where the Contractor may be instructed in writing during the course of the project not to place embedded conduits in certain areas, generally due to the possibility of unsightly cracking or for structural reasons. This instruction shall not entitle the Contractor to extra compensation. Any condition not covered by the following usual conditions shall require special clarification.

	Location	Maximum Allowance
1.	Columns	Displacement of 4 percent of plan area of column.
2.	Floors and Walls	Displacement of 1/3 of thickness of concrete spaced not less than three diameters on center.
3.	Beams and Joists	Displacement of 1/3 of least dimension, spaced not less than three diameters on center.
4.	Sleeves thru Floors and Walls	2" maximum pipe size, not less than three diameters on center.

H. Plain Concrete: Raceways shall not be placed in plain concrete, such as cement toppings on structural floors without special instructions.

I. Furred Spaces: Raceways installed in furred spaces shall be installed in accordance with the requirements of the National Electrical Code. Do not anchor or strap conduits to the ceiling furring channels or attach to furred ceiling hanger wires. Raceways may be attached to the suspension system (wire hangers) of drop ceilings if installed in such a manner that the ceiling panels may be removed without interference with the raceway, and the wire hangers are sized to carry the additional raceway load.

J. Stub Ups: Extend conduit stubs at least one foot above slab or fill, before connection is made to electrical metallic tubing.

K. Exterior Conduits: Install raceways a minimum of 42” below finished grade unless noted otherwise on the drawings.

L. Provide marking of conduit and junction boxes to indicate which distribution system they are serving. The markings could be colored tape on conduit at or near junction boxes with different colored tapes indicating different distribution systems. Concealed junction boxes shall be legibly marked with a magic marker to indicate the panel and circuit number that junction box serves. All covers for wiring boxes used for fire alarm systems shall be colored red and labeled "fire alarm" using a phenolic equipment nameplate.

1. The distribution systems shall be color coded as follows:

   a. Fire Alarm - Red
   b. 120/208 Volt - Green
   c. 277/480 Volt - Orange
   d. Cable TV System - Black
   e. Telephone System - White

M. Steel Conduit (galvanized rigid steel, IMC or EMT):

1. Cutting: Cutting shall be done with hand or power hacksaws. All cut ends shall be reamed to remove burrs and sharp edges.
2. All threaded joints shall be made up wrench-tight and all compression joints shall be made up mechanically secure and snug so as to make continuous current-carrying electrical contact.
3. All metallic conduits buried or otherwise in contact with earth shall be painted using one heavy continuous coat of asphalt varnish after assembly of conduit and fittings.
4. Elbows for rigid metal conduit, 3 inches and larger, shall be either plastic coated or tape coated rigid metal conduit to prevent damage from pull ropes.
5. Rigid metal conduit shall be used for at least the first 5 feet of horizontal run out from the building to allow for building settling over time.
6. Expansion joints shall be installed in steel conduit systems in structures as follows expansion joints are specified elsewhere in the specification):

   a. Where conduit run crosses a building expansion joint.
   b. In any conduit run exceeding 100 feet in length.
   c. Where shown on the drawings.

N. Threads: Clean all threads of rigid or intermediate metal conduit. Coat all male threads of all steel conduit installed in concrete with red or white lead immediately before being coupled together.

O. Running Threads: Use "Erickson" type couplings in lieu of running threads.

P. PVC Conduit:

1. Joints: Conduits shall be joined by using couplings and solvent cement furnished or recommended by the raceway manufacturer. Finished joints shall be secure and watertight.

2. Cutting: Cutting shall be done with hacksaws and ends shall be reamed to remove burrs and sharp edges.
3. Expansion Joints: Expansion joints shall be installed:

    a. Where conduit run crosses a building expansion joint.
    b. As recommended by the manufacturer or as shown on the drawings.

4. Bends for PVC conduit sizes 2" and smaller may be made "hot" in the field. Inside dimension shall be thereby undistorted. For PVC sizes larger than 2", provide only factory bends.

END OF SECTION 26 05 33

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 73 – LOW VOLTAGE ELECTRICAL SYSTEMS STUDIES

1. GENERAL

1.1 DESCRIPTION OF WORK

A. The scope of this section is to provide requirements for low voltage (600 volts and below) studies and documentation. This includes short circuit analysis with equipment evaluation, overcurrent protective device coordination, and arc flash analysis.

B. **The Coordination Study and the Arc Flash Hazard Analysis shall be submitted along with and at the same time as the shop drawings for all pertinent electrical distribution equipment. Electrical distribution equipment shall not be released for purchase until study has been reviewed and approved by engineer.**

2. EXECUTION

2.1 SUBMITTALS

A. A coordination study shall be provided by the contractor for this project. The study shall include maximum short circuit calculations, a complete coordination analysis, and settings for all protective devices with adjustable set points. The protective device settings must address the need to minimize arc flash hazards while maintaining proper system coordination. The coordination study shall be based on the specific devices installed and include all **new equipment and all existing equipment required in order to complete the study for the new equipment** (including, but not be limited to) the following:

1. Service Entrance Equipment.

    a. All overcurrent protective devices installed in service entrance panels/switchboards.

2. Feeder Circuits.

    a. All three (3) phase feeder circuit overcurrent protective devices.

3. Branch Circuits.

    a. All three (3) phase branch circuit overcurrent protective devices. installed with a rating equal to or greater than 30 amps.
    b. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.

4. Motor Control Centers

    a. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.

5. Format

   a. The coordination study shall be reviewed and updated to reflect any changes within one week of the final electrical walk through for project.
   b. The low voltage coordination study shall include the stamp or seal and signature of the preparing engineer, and shall be reviewed by the Engineer of Record.
   c. A complete set of manufacturers' descriptive literature and detailed instructions for adjusting overcurrent protective devices shall be provided to the Owner's Representative within six (6) weeks after overcurrent protective device shop drawings have been approved.
   d. The low voltage coordination study shall be provided using the SKM Systems Analysis, Inc SKM Power Tools Electrical Engineering Software (PTW 32).
   e. Prior to project completion, the low voltage coordination study shall be provided to the Owner's Representative in both hard copy and in digital format. The hard copy shall include time current curves (for phase and ground fault settings) for each panel and the corresponding TCC report clearly showing each device set point. The digital copy shall include the complete coordination file including all device curves (use the SKM "Project - Backup" command).

B. A low voltage Arc Flash Hazard Analysis shall be provided by the contractor for this project. The analysis shall be based on the specific equipment installed, and shall be updated to include project "as built" documentation. The Arc Flash Hazard Analysis shall utilize owner's existing SKM study for the existing portion of the electrical distribution and shall be updated/expanded for all new equipment installed under this project's scope of work. Coordinate with owner. Where the arc flash incident energy greater than 8 cal/cm2, the overcurrent protective device coordination study shall be reviewed and recommendations shall be provided to reduce the hazard/risk level. The analysis shall be based on the specific devices installed and include all **new equipment and all existing equipment required in order to complete the study for the new equipment** (including, but not be limited to) the following:

   1. Service Entrance Equipment.

      a. All overcurrent protective devices installed in service entrance panels/switchboards.

   2. Feeder Circuits.

      a. All three (3) phase feeder circuit overcurrent protective devices.

   3. Branch Circuits.

      a. All three (3) phase branch circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
      b. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.

   4. Motor Control Centers.

a. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.

5. The project shall include printed waterproof labels for equipment that lists the specific arc flash hazard/risk category at each location.

6. Format

a. The Arc Flash Hazard Analysis shall be reviewed and updated to reflect any changes and corrections to conductor length within one week of the final electrical walk through for the project.
b. The low voltage arc flash hazard analysis shall include the stamp or seal and signature of the preparing engineer, and shall be reviewed by the Engineer of Record.
c. Owner approved Arc Flash Hazard warning labels shall be furnished and installed prior to project completion.

1) The project include color, printed waterproof labels.
2) For incident energy values less than or equal to 40 cal/cm2, label shall indicate “WARNING” using black lettering on orange background.
3) For incident energy values greater than 40 cal/cm2, label shall indicate “DANGER” using white lettering with red background.
4) Labels installed outdoors shall be resistant to ultraviolet light.
5) At a minimum, each label shall list the following:

a) Location
b) Source protective device name providing the protection (fed from)
c) Nominal system voltage
d) Arc flash boundary
e) Specific arc incident energy available
f) Bolted Fault Current available
g) Label Date

d. The low voltage arc flash hazard analysis shall be provided using the SKM Systems Analysis, Inc SKM Power Tools Electrical Engineering Software (PTW 32). Do not use the “Use Equipment Specific Arc Flash Equation in Protective Device Library” method for arc flash calculation in the SKM Software.
e. Prior to project completion, the low voltage arc flash hazard analysis shall be provided to the Owner’s Representative in both hard copy and digital format. The hard copy shall clearly show each device set point. The digital format shall include the complete coordination file including all device curves (use the SKM “Project - Backup” command).

END OF SECTION 26 05 73

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260800 - ELECTRICAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Validation of proper installation of Divisions 26 systems and equipment

B. Systems and equipment testing and startup

C. Equipment performance verification

D. Functional testing of control systems

E. Documentation of tests, procedures and installations

1.2 SCOPE INCLUDES

A. Systems to be commissioned include the following:

1. Power Distribution [Panelboards and Transformers]
2. Emergency Power

1.3 RELATED DOCUMENTS

A. Commissioning Plan - This plan is part of the Contract Documents and outlines many responsibilities, procedures and tasks throughout the commissioning process.

B. Section 019113 – General Commissioning Requirements

C. Section 230800 – Mechanical Commissioning Requirements

D. Division 26 Sections - Individual Sections stipulate installation, startup, warranty and training requirements for the system or device specified in that Section.

1.4 REFERENCES

A. ASHRAE Guideline 0-2013: The HVAC Commissioning Process.

B. ANSI/NEBB S110-2019 - Whole Building Technical Commissioning of New Construction

1.5 GENERAL DESCRIPTION

A. Commissioning is a process to assure all building systems are installed and perform interactively according to the design intent; the systems are efficient, cost effective and meet the Owner’s operational needs; the installation is adequately documented. Commissioning

serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance building systems from installation to fully optimized operation.

B. The Commissioning Authority will work with the Contractor and Design Engineer to coordinate, oversee, and document the commissioning process during the Construction Phase of this project.

C. This Section defines responsibilities of the Contractor to facilitate the commissioning process particularly during the Construction Phase of the project.

1.6 DEFINITIONS

A. Refer to specification section 019113 for definitions related to the commissioning process.

1.7 DOCUMENTATION

A. Contractor shall send Commissioning Authority one copy of the following per the procedures specified in other sections of the Specification:

1. Shop drawings and product data related to systems and equipment to be commissioned on this project. CxA will review and incorporate comments via the Design Engineer.
2. Initial draft of equipment startup plan checklists along with manufacturers' startup procedures. CxA will assist in development and recommend approval.
3. System Test Reports. CxA will review and compile prior to FPT.
4. System certificate of readiness including completed equipment startup forms along with the manufacturers' field or factory performance test documentation. CxA will review and approve prior to FPT.

1.8 SEQUENCING AND SCHEDULING

A. Systems can be in various stages of the commissioning process where appropriate, in order to expedite close out of the facility. The CxA and Contractor shall cooperate to schedule Cx tasks to minimize the duration of Cx activities. Sequential priorities shall be followed per the Cx Plan.

B. Commissioning Schedule - Contractor shall incorporate the commissioning process into the project schedule. Startup, TAB and FPT shall be itemized as applicable for each system. Durations for each task shall be coordinated with the CxA.

1.9 COORDINATION MANAGEMENT PROTOCOLS

A. Coordination responsibilities and management protocols relative to Cx are initially defined in the Cx Plan but will be refined and documented at the commissioning scoping meeting. Contractor shall have input to the protocols and all parties will commit to scheduling obligations. The CxA will record and distribute notes from the meeting.

1.10 CONTRACTOR RESPONSIBILITIES

A. Construction Phase

1. Include commissioning requirements in price and plan for work.
2. Attend scoping and coordination meetings scheduled by the CxA.
3. Remedy deficiencies identified during the construction period.
4. Prepare and submit required draft forms and equipment information requested by the CxA. Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA.
5. Assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
6. Provide limited assistance to the CxA in preparing the specific functional performance test procedures. Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
7. Where functional testing is to be executed by the system/equipment provider (see “Systems/Equipment to be Commissioned”) the Contractor, with the CxA’s assistance, will develop final functional test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested.
8. Thoroughly complete and inspect installation of systems and equipment in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this Section.
9. Startup systems and equipment prior to verification and performance testing by the CxA. Startup procedures shall be in accordance with Contract Documents, reference or industry standards, and specifically Part 3 of this Section.
10. Record startup and test procedures on startup forms and checklists and certify the systems and equipment have been started and tested in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this Section. Each form shall be signed and dated by the individual responsible for the startup or test.
11. Complete pre-approved startup checklists and submit along with other installation certification documentation such as certificate of readiness, warranties, test results, etc.
12. Schedule and coordinate Cx efforts required by appropriate subcontractors and vendors.
13. Demonstrate the systems as specified.
14. Certify systems have been installed and are operating per Contract Documents through certificates of readiness.
15. Maintain an updated set of record documentation.

16. Copy CxA on indicated documentation.

17. Conduct equipment operation, maintenance, diagnosis and repair training as required by the respective section of the Specifications.

B. Acceptance Phase

1. Assist CxA in verification and performance testing. Assistance will generally include the following:

a. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

b. Manipulate systems and equipment to facilitate testing.

c. Manipulate control systems to facilitate verification and performance testing.

2. Correct any work not in accordance with Contract Documents and non-conformances included in the commissioning issues log.

C. Warranty Phase

1. Provide warranty service.

2. Correct any deficiencies identified.

3. Update record documentation to reflect any changes made throughout the Warranty Phase.

1.11 CONTRACTOR NOTIFICATION

A. Contractor shall completely install, thoroughly inspect, startup systems and equipment. All activities shall be documented on specified forms. Contractor shall notify Design Engineer, Owner and CxA via the certification of readiness that systems are complete and ready for verification and functional performance testing.

B. Contractor shall notify CxA at least 10 business days in advance of any tests or startups. CxA shall witness selected tests and startups.

1.12 STARTUP CHECKLISTS

A. Startup checklists for each type of equipment and system shall be submitted to CxA for approval prior to startup. The forms shall be designed by the appropriate subcontractors or vendors to meet the requirements of the Contract Documents. Forms shall be developed for the specific equipment being installed for this project.

B. Startup checklists shall generally include the following for each (as applicable):

1. Project specific designation, location and service

2. Pertinent nameplate data

3. Indication of the party performing the test

4. Field for signature of the startup technician along with the date

5. Clear explanation of the inspection, test, measurement, etc. with a pass/fail indication and a record of measurement parameters
6. Checklist space that proper maintenance clearances have been maintained
7. Checklist space indicating that any required special tools and/or spare tools were turned over to the Owner
8. Checklist space indicating that required prerequisite equipment and systems were successfully started.

C. Startup checklists shall incorporate the manufacturer-specified procedures. Contractor shall compile the startup and checkout procedures indicated in the manufacturer's documentation prior to designing the forms. Include specified acceptance criteria as applicable. The manufacturer's startup and checkout procedures shall be submitted to the CxA along with the draft startup checklists.

D. Completed startup plans for all pieces of equipment included in a system shall be submitted to CxA prior to verification and performance testing.

E. See specification 019113 for additional information regarding Startup Checklists.

1.13 FUNCTIONAL PERFORMANCE TESTING

A. Participation: CxA will coordinate, test and/or witness functional performance tests after the successful startup and documentation of systems and equipment is complete. Contractor shall assist, as described above, with manipulation of the systems or equipment; provision of supporting equipment or materials (lifts, ladders, specialty test equipment, etc.); and on the spot remediation of minor identified deficiencies.

B. Detailed Test Forms: CxA will prepare detailed testing procedures and forms to conduct and document the FPT. These will be developed during the Construction Phase and completed during the Acceptance Phase.

C. Test Documentation: CxA will record test results on the forms developed for the testing. CxA will Pass or Fail the testing and record the date and time of the test. Deficiencies shall clearly indicate when the test has failed. CxA shall recommend acceptance of the system or component after all related testing is successfully complete.

D. Deficiencies and Retesting: When deficiencies are identified during testing, depending on their extent or magnitude, they can be corrected during the test and the testing can continue to successful completion. Significant deficiencies will fail the test and require retesting of the affected portions of the test. The CxA will subsequently track the resolution of the deficiency via the Project Deficiency List. All tests shall be repeated until successful completion.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

A. This Section outlines specific startup, checkout, and functional testing requirements for systems and equipment. Generally, these procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct. These requirements along with those specified in the individual Section provide a minimum guideline for development of startup procedures, checklists and tests. Contractor shall synthesize these requirements with that of the manufacturer's and/or applicable codes and standards to develop specific and itemized startup procedures specific to that installed on this project.

B. Refer to all Division 26 Specifications for tests performed on installed equipment and systems.

3.2 STARTUP

A. The contractor shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 019113. The Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning authority or Owner.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and Contractor. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all startup plan checklists as soon as possible.

3.3 STARTUP/CHECKOUT

A. Verify that equipment testing work is complete before starting functional performance of power equipment.

B. Inspect equipment and confirm that it is clean and ready for operation. All shipping tags removed, nameplates installed and equipment manuals in place.

C. Verify all equipment labeling corresponds with drawings and indices and meets required Specifications. Correct any deficiencies for electrical systems.

3.4 POWER DISTRIBUTION – STARTUP/CHECKOUT

A. Overcurrent protective device settings coordinated and adjusted per the study results.

B. System in place and tested, including all components indicated.

C. Connected to utility company power system on a permanent basis.

D. Wiring installed in conduits or other raceways.

E. System checked for unwanted grounds, short circuits or open circuits.

F. Ground installed as indicated, including transformers.

G. Equipment connections properly torqued.

H. Equipment, where indicated, on housekeeping pads.

I. Equipment cleaned and shipping blocks removed.

J. Equipment labeled.

K. Boxes and nameplates meet color coding requirements.

3.5 EMERGENCY POWER DISTRIBUTION – STARTUP/CHECKOUT

A. System in place and tested, including all components indicated.

B. Facility shall be connected to utility company power system on a permanent basis before emergency checklist is addressed.

C. Wiring installed in conduits or other raceways.

D. System checked for unwanted grounds, short circuits or open circuits.

E. Grounds installed as indicated, including transformers.

F. Ground fault settings made.

G. Equipment connections properly torqued.

H. Equipment, where indicated, on housekeeping pads.

I. Equipment cleaned and shipping blocks removed.

J. All ATS delay and timer settings are programmed.

K. Equipment labeled.

L. Boxes and nameplates meet color coding requirements.

M. Proper phase rotation coordinated between emergency and normal sources

3.6 FUNCTIONAL TESTING

A. This section specifies the functional testing requirements for Division 26 systems and equipment. From these requirements, the Commissioning Authority (CxA) shall develop step-by-step procedures to be executed by the Contractors or the Commissioning Authority. The general functional testing process, requirements and test method definitions are described in Section 019113. The test requirements for each piece of equipment or system contain the following:

1. The contractors responsible to execute the tests, under the direction of the CxA

2. A list of the integral components being tested

3. Startup plan checklists associated with the components
4. Functions and modes to be tested
5. Required conditions of the test for each mode
6. Special procedures
7. Required monitoring
8. Acceptance criteria

B. PREREQUISITES

1. The following applicable generic prerequisite checklist items are required to be completed and submitted with the equipment/system certificate of readiness and checked off by CxA prior to functional testing.
2. All related equipment has been started up and startup plan checklists submitted and approved ready for functional testing.
3. All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.
4. Test and balance (TAB) complete and approved for the air and hydronic systems
5. All A/E punchlist items for this equipment corrected
6. Schedules and setpoints provided to the CxA
7. False loading equipment, system and procedures ready
8. Sufficient clearance around equipment for servicing

C. MONITORING

1. Monitoring is a method of testing as a stand-alone method or to augment manual testing.
2. All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. At the option of the CxA, some control system monitoring may be replaced with datalogger monitoring. At the CxA's request, the controls contractor shall trend up to 20% more points than listed herein at no extra charge.
3. Trend output data must be in an ASCII delimited text file with time continuous down left column and point values in column(s) to the right.
4. All trends for points of a group must start at the same moment in time, unless specifically approved otherwise with the commissioning agent.

3.7 NORMAL POWER SYSTEMS FPT

A. Parties Responsible to Execute Functional Test

1. Electrical contractor: perform functional testing
2. CxA: to witness, direct and document testing.
3. Equipment manufacturer's representative, as required.

4. Owner's Representative
5. Owner's maintenance staff, as desired.

B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.7.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

C. Functions / Modes Required to be Tested

1. Activate system by connection to utility power.
2. Verify voltages and amperes at meters on switchgear.
3. Verify voltages and amperes at switchgear, switchboards, motor control centers, panelboards, and transformers, both primary and secondary.
4. Verify voltages and amperes at mechanical motors and other major pieces of equipment.

D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

E. Acceptance Criteria

1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR POWER SYSTEMS TEST

3.8 EMERGENCY POWER SYSTEMS FPT

A. Parties Responsible to Execute Functional Test

1. Electrical contractor: perform functional testing
2. CxA: to witness, direct and document testing.
3. Equipment manufacturer's representative, as required.
4. Owner's Representative
5. Owner's maintenance staff, as desired.

B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.5.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

C. Functions / Modes Required to be Tested

1. Activate system by manual transfer from utility power.
2. Demonstrate automatic transfer of power.

D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

E. Acceptance Criteria

1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR EMERGENCY POWER SYSTEMS TEST

END OF SECTION 260800

SECTION 26 22 00 - DRY-TYPE TRANSFORMERS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Extent of transformer work is indicated by drawings and schedules.

B. Types of transformers specified in this Section include the following:

1. Energy Efficient Dry-type Transformers
2. Shielded, Isolation Type Transformers

C. Refer to other Division 26 sections for electrical wiring connections required in conjunction with transformers; not work of this Section.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of power distribution transformers of types and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer: Qualified with at least three (3) years successful installation experience on projects with electrical power/distribution transformer work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with NEC as applicable to installation and construction of electrical power/distribution transformers.

B. NEMA Compliance: Comply with applicable portions of the NEMA Std. Pub. Nos. TR1 and TR27 pertaining to power/distribution transformers.

C. ANSI Compliance: Comply with applicable ANSI standards pertaining to power/distribution transformers.

D. ANSI/IEEE Compliance: Comply with applicable ANSI/IEEE standards pertaining to power/ distribution transformers..

E. ANSI/NEMA Compliance: Comply with NEMA Std. ST 20 "Dry-Type Transformers for General Applications".

F. ANSI/UL Compliance: Comply with applicable portions of ANSI/UL 506 "Safety Standard for Specialty Transformers".

G. UL Labels: Provide distribution transformers that have been UL listed and labeled.

H. IECC Compliance: Transformers shall be fully compliant with provisions of the International Energy Conservation Code, 2018 Edition.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data including KVA rating, frequency, primary and secondary voltages, percent taps, impedance and certification of transformer performance efficiency at indicated loads, no load and full load losses in watts, hot spot and average temperature rise above 40 degrees C ambient, sound level in decibels, and standard published data.

B. Shop Drawings: Submit manufacturer's drawings indicating dimensions and weight loading for transformer installations.

2. PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of transformer):

A. Cutler Hammer

B. General Electric Co.

C. Square D Co.

D. Siemens

2.2 EQUIPMENT

2.3 Furnish and install dry-type transformers as shown on the drawings.

A. Transformer coils shall be of the continuous **copper wound construction**.

B. All transformer cores shall be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point to prevent core overheating. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

C. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.

D. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.

E. Dry-type transformers shall have metallic enclosures designed to provide for air cooling and to prevent accidental contact with live conductors. Materials and final performance of the product must conform to applicable IEEE and NEMA standards. Transformer wiring compartment shall be located below the core and coil, and shall be cooled by air circulation, or the wiring compartment shall be insulated from the core and coil by means of a suitable thermal insulation barrier. All transformers shall be UL listed and shall bear the UL label.

F. Transformers shall operate, without cooling fans, at 100% nameplate KVA rating continuously while in a 40 degrees C ambient environment without exceeding the rated average winding temperature rise of the ANSI insulated system used. Specific KVA and voltage ratings required shall be as shown on the drawings. Transformers rated above 30 KVA shall have a 220 degrees C insulation system with 115 degrees C average temperature rise or 180 degrees C hot spot rise in a 40 degrees C ambient. Transformers rated 30 KVA and below shall have a 180 degrees C insulation system with 115 degrees C average temperature rise or 145 degrees C hot spot rise in a 40 degrees C ambient.

G. Sound levels must fall within ANSI-NEMA Standard levels according to KVA size.

H. Sound levels shall be warranted by the manufacturer not to exceed the following:

1. 15 to 50KVA - 45dB; 51 to 150kVA - 50dB; 151 to 300kVA - 55dB; 301 to 500kVA - 60dB; 501 to 700kVA - 62dB; 701 to 1000kVA - 64dB; 1001 to 1500kVA - 65dB; 1501 to 2000kVA- 66Db.

I. All transformers shall be supplied with clamp-type solderless connectors suitable for use with copper connecting cables.

J. All transformers shall have neoprene rubber pads between the core and coil assembly and the transformer enclosure to isolate sound and vibration. A flexible conduit connection to the transformer may be used.

K. Terminal boards shall be provided on all transformers. High-voltage and low-voltage terminals must be held in a fixed position, thus removing any need for taping of cable-terminal connections.

L. Transformers which weigh more than 50 pounds must have external lifting provisions for ease in handling.

M. Single phase transformers over 10 KVA and three-phase transformers 6 KVA and above shall have minimum full load rated taps in the high-voltage windings as follows: (6) 2-1/2% full

capacity taps, 3 above and 3 below normal rated voltage. Transformer taps shall be adjusted to deliver nominal system voltage at branch circuit panels.

3. EXECUTION

3.1 Install transformers as indicated in compliance with the manufacturers' written instructions, applicable requirements of the NEC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

3.2 Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

3.3 Install transformers on vibration mounts; comply with manufacturers recommended installation methods, if applicable.

3.4 Clearances shall be maintained around transformers in accordance with all applicable codes, standards and manufacturer’s installation instructions.

END OF SECTION 26 22 00

SECTION 26 24 13 - SWITCHBOARDS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1-specification sections apply to work of this Section. Division 26 "Basic Materials and Methods" sections apply to work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Drawings and schedules indicate extent of switchboard work.

B. Types of switchboards specified in this Section include the following:

1. Dead Front Distribution
2. Circuit Breaker Switchboards

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of switchboards of types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects utilizing switchboards similar to those for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with the NEC as applicable to wiring methods, construction and installation of switchboards.

B. UL Compliance: Comply with applicable requirements of Standard 486A, "Wire Connectors and Soldering Lugs For Use With Copper Conductors", and Standard 891, "Dead-Front Electrical Switchboards", pertaining to installation of switchboards. Provide switchboards and components that are UL listed and labeled.

C. IEEE Compliance: Comply with applicable requirements of IEEE Standard 241, "Recommended Practice for Electrical Power Systems in Commercial Buildings", pertaining to switchboards.

D. ANSI Compliance: Comply with applicable requirements of ANSI standards pertaining to switchboard assemblies.

E. NEMA Compliance: Comply with applicable portions of NEMA Standards Publication Number PB 2, "Dead-Front Distribution Switchboards"; PB 2.1, "Instructions for Safe Handling, Installation, Operation and Maintenance of Switchboards", and SG 3, "Low-Voltage Power Circuit Breakers", pertaining to switchboard assemblies.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's data on switchboards including, but not limited to, voltage, number of phases, frequency, short-circuit and continuous current ratings. Provide application data for main and branch circuit devices, sections, main buses, and basic insulation levels.

B. Shop Drawings: Submit layout drawings of switchboards showing accurately scaled basic equipment sections including auxiliary compartments, section components, and combination sections.

C. Wiring Diagrams: Submit wiring diagrams for switchboards showing connections to electrical power feeders and distribution branches. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.

2. PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide switchboards of one of the following (for each type and rating of switchboard):

1. Square D Company
2. General Electric Company
3. Cutler Hammer
4. Siemens

2.2 GENERAL CONSTRUCTION

A. Where indicated, furnish and install an indoor dead front type, completely metal enclosed, low voltage, self-supporting switchboard structure independent of wall supports. Voltage rating shall be as indicated on the drawings. It shall consist of the required number of vertical sections bolted together to form one rigid switchboard with a nominal height of 90 inches. The sides and rear shall be covered with removable screw-on plates having formed edges all around.

B. Equipment shall comply with the latest applicable standards of NEMA, ANSI and UL.

C. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips.

D. Switchboards shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.

E. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and finished with gray baked enamel over a rust-inhibiting phosphatized coating. Color shall be ANSI 49 or ANSI 61, gray.

F. Nameplates shall be furnished for all main and feeder circuits including control fuses for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish Master Nameplate giving switchboard designation, voltage and ampere rating, bracing, manufacturer's name, general order number and item number.

G. Provide flash hazard labeling in accordance with National Electrical Code requirements. Reference specification section 260500 for arc flash labeling requirements.

H. All bus bars shall be plated copper. Plating shall be applied continuously to all bus work. The switchboard bussing shall be of sufficient cross-sectional area to meet UL standard 891 temperature rise requirements. The phase and neutral through-bus shall have ampacities as indicated on the drawings. Bus current density is not to exceed 1,000 amps/in^2. The neutral bus shall be of equivalent ampacity to the phase bussing. Tapered bus is not acceptable. Full provisions for the addition of future switchboard sections shall be provided. Bus connections shall be bolted with Grade 5 bolts and conical spring washers. The ground bus shall be sized in accordance with NEC and UL 891 requirements and shall extend the entire length of the switchboard. The bus work shall be braced for 100,000 RMS symmetrical amps at rated voltage. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. All hardware used on conductors shall have high-tensile strength zinc plating. All terminals shall be of the anti-turn solderless type suitable for Cu and Al cable of sizes indicated.

I. Furnish cable pull sections or cable pull boxes as required complete with cable tie down supports. Where cable pull section or pull boxes contain utility service cables provide utility acceptable sealing means.

J. All factory-installed devices shall be re-torqued prior to energizing.

K. Assembly Temperature Ratings:

1. Ambient: -30 degrees Celsius minimum, 40 degrees Celsius maximum
2. Full load rise of 65 degrees Celsius maximum above ambient
3. Full assembly shall achieve rated capabilities without the use of forced air ventilation

L. All trip indications, trip reset, and metered values shall be displayed on the front of the assemblies without removal of any covers.

M. All settable relays or other devices mounted inside the assemblies shall be installed in compartments with a hinged cover.

N. Infrared inspection window shall be provided to allow energized inspection of all connections.

O. Coordination: The equipment dimensions indicated on the drawings are based on Square D published data. If other acceptable manufacturer's equipment is proposed and exceeds these dimensions, it shall be the responsibility of the Contractor to coordinate the equipment arrangement within the room with all affected trades to provide all code clearances and proper arrangements. Switchboards that grossly exceed the space allocated and that would require an increase in room size are not acceptable.

2.3 SWITCHBOARD TYPE

A. Switchboards shall be of construction equal to Square D Power-Style, QED type. Each main switchboard shall be front accessible. Switchboard sections shall be no greater than 91.5" in height, including 1.5" floor sills.

2.4 CUSTOMER METERING

A. Where indicated on the drawings, digital electronic power meter with the following monitoring and metering capabilities:

1. Current, per phase and neutral.
2. Voltage, phase-to-phase and phase-to neutral.
3. Real power (kW), per phase and three-phase total.
4. Reactive power (kVAR), per phase and three phase total.
5. Apparent power (kVA), per phase and three phase total.
6. Power factor (true), per phase and three phase total.
7. Frequency.
8. Demand current, per phase and neutral, present and peak.
9. Real power demand (kWd), three phase total, present and peak.
10. Reactive power demand (kVARd), three phase total, present and peak.
11. Apparent power demand (kVAd), three phase total, present and peak.
12. Real energy (kWh), three phase total.
13. Reactive energy (kVARh), three phase total.
14. Apparent energy (kVAh) three phase total.
15. Energy accumulation modes, signed, absolute, energy in, energy out.
16. Total harmonic distortion (THD), voltage and current, per phase.
17. Date and time stamping, peak demands, power up/restart and resets.

B. The power meter shall be accurate to 0.25% of the reading plus 0.05% of the full scale for voltage and current sensing, and 0.5% of the reading plus 0.05% of the full scale for power and energy, accurate through the 31st harmonic.

C. Provide necessary current transformers to support current inputs to the power meter. Provide potential transformers, control power transformers, and fusing as required.

D. Each power meter shall have a built-in RS-485 data communications port to allow for future multi-point communication to multiple computer workstations.

E. The power meter shall include self-diagnostics to indicate mis-wired installations.

2.5 MAIN AND FEEDER PROTECTIVE DEVICES

1. The following paragraphs list the general feeder protective device requirements:

B. MAIN PROTECTIVE DEVICES

1. Main circuit breakers shall be of the individually stationary mounted, two-steps stored energy type (Square D Masterpact, or equivalent). They shall be UL listed for 100% continuous current when applied in Square D QED style switchboards. Sensor and frames ratings shall be as shown in the drawings.
2. Main protective devices shall be provided with a fixed instantaneous (high-level selective override) circuit. The circuit shall have a defeatable instantaneous adjustment to allow the breaker to remain closed for up to 30 cycles during overcurrents that are below the rms symmetrical short time withstand ratings. The circuit shall instantaneously trip when current levels exceed applicable withstand ratings.
3. Main circuit breakers shall use a glass reinforced insulating material providing high dielectric strength. Current carrying components of the circuit breakers shall be completely isolated from the handle and the accessory mounting area. Breakers shall have common tripping of all poles and shall be trip free. Circuit breakers shall be UL Listed for reverse connection without requiring special construction or labeling. The breakers shall have quick-make, quick-break contacts with a maximum 5 cycle closing time. Circuit breakers shall be equipped with electrical accessories as noted on the drawings.
4. Main circuit breakers shall be factory sealed and shall have a date code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.
5. Breaker faceplates shall indicate rated ampacities, and UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings.
6. Each circuit breaker shall be equipped with a push-to-trip button to mechanically operate the circuit breaker tripping mechanism.
7. Each main circuit breaker shall be provided with a true two step, stored energy mechanism for 5-cycle closing. The energy required to close the circuit breaker shall be stored pending release to close action. Main circuit breakers shall have multiple CHARGE/CLOSE provisions allowing the following sequence: CHARGE, CLOSE, RECHARGE, OPEN/CLOSE/OPEN.

8. Each main circuit breaker shall be provided with local control push buttons to OPEN and CLOSE the circuit breaker. Color-coded visual indication of contact position (OPEN or CLOSED) shall be provided on the front of the breaker. Each circuit breaker shall provide for local manual charging following a CLOSE operation. Color-coded visual indication of the mechanism CHARGED and DISCHARGED position shall be provided on the face of the circuit breaker. The visual indicator shall indicate CHARGED only when closing springs are completely charged.
9. **Each main breaker shall be provided with a 3-phase voltage monitoring relay for monitoring/control of single phase, phase unbalance, phase failure detection, phase sequencing, and phase reversal. Monitoring relay shall trip the main breaker when outside of tolerances. Initial tolerances shall be set to 8 percent with time delay of 3 seconds. Tolerances shall be field adjustable. The voltage monitoring relay shall include a stored energy device such as a trip capacitor. The voltage monitoring relay shall not operate when power is lost to all three phases. Indication of relay trip and manual reset shall be visible on the front side of the switchboard without removal of any covers.**
10. The entire trip system shall be a microprocessor-based, true rms sensing design (Square D MICROLOGIC Full Function or approved equivalent) with sensing accuracy through the 13th harmonic. Provide the following time/current curve adjustments to maximize system selective coordination capabilities. Each adjustment shall have discrete settings and each function shall be independent from all other adjustments.

    a. Adjustable long time ampere rating and delay.
    b. Adjustable short time pickup and delay (delay includes I^2t IN and I^2t OUT).
    c. Adjustable defeatable instantaneous pickup (with OFF position).
    d. Adjustable ground fault pickup and delay (delay includes I^2t IN and I^2t OUT).
    e. High level selective override.

11. Each circuit breaker trip system shall include an externally accessible test port for use with a universal equipment test set. One test set will be provided to the Owner with the switchboard and shall be suitable for testing all electronic circuit breakers specified for this project. No disassembly of circuit breakers shall be required for testing.
12. Circuit breaker lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 75°C wire, or 90°C wire sized in accordance with the 75°C temperature rating in the NEC. All circuit breakers shall be UL Listed to accept field installable/removable compression type lugs. All circuit breakers shall be suitable for bus connection.
13. **For all circuit breakers rated 1200 Amps or more, provide circuit breaker with an energy reducing maintenance switch per NEC paragraph 240.87. Maintenance switch shall be a two position, lockable device with a locally mounted blue strobe beacon enabled when in maintenance mode. System shall have one spare set of contacts for future use.**
14. Main service entrance circuit breaker shall be a motor operated breaker. Motor operator shall automatically charge trip and close mechanism and electrically operated trip and solenoids to allow remote trip/close from a pushbutton station. **Pushbutton station shall not be a corded remote for operation of main circuit breaker.** See Plans and details for additional information.

C. FEEDER PROTECTIVE DEVICES

1. Feeder protective devices as shown shall be molded case air circuit breakers, built, tested and UL labeled per UL 489.
2. Breakers with 100 ampere through 400-ampere frames shall be thermal-magnetic trip with inverse time current characteristics. Breakers with 225 ampere through 400-ampere frames shall have continuously adjustable magnetic pick-ups of approximately five to ten times trip rating.
3. Breakers with 600 ampere frames and above shall be Square D Powerpact or approved equivalent with solid-state trip complete with built in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have easily changed trip-rating plugs with trip ratings as indicated on the drawings. Rating plugs shall be interlocked so they are not interchangeable between frames and interlocked such that breakers cannot be latched with rating plug removed. Breaker shall have built-in test points for testing long delay, instantaneous and ground fault (where shown). Functions of the breaker shall be tested by means of a 120 volt operated test kit. Provide one test kit capable of testing all breakers 600 ampere and above.
4. Solid state instantaneous element shall be continuously adjustable from approximately 4 to 8 times the trip rating, with short time adjustment from instantaneous to 10-cycle delay for coordination purposes. Provide short delay override feature providing for instantaneous tripping on high magnitude faults.
5. Molded case breakers shall have a minimum UL listed interrupting capacity as listed on the drawings.
6. For all circuit breakers rated 1200 Amps or more, provide circuit breaker with an energy reducing maintenance switch per NEC paragraph 240.87.
7. Breakers 2000 thru 3000A frame on the drawings shall be UL listed and labeled for 100 percent application per the N.E.C.

2.6 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) EQUIPMENT

A. Where indicated on the drawings, provide switchboards with integral TVSS equipment according to the following:

B. Transient voltage surge suppression (TVSS) equipment shall be designed for non-linear loads incorporating transient voltage surge suppression and high-frequency electrical line noise filtering connected in parallel with the facility's wiring system. The specified unit shall be suitable for non-linear loads and shall provide effective high-energy transient voltage suppression, surge current diversion, high-frequency electrical line noise attenuation, and line control in ANSI/IEEE C62.41-1991 environments when connected downstream from the facility's main overcurrent device.

C. The manufacturer of the unit must have been engaged in the design and manufacture of such products for a minimum of five years.

D. The specified unit shall be designed, manufactured, tested and installed in compliance with the latest edition of the following standards:

1. ANSI/IEEE C62.41, C62.45
2. FIPS PUB 94
3. NEMA LS-1
4. NFPA 70, 75 and 78
5. UL 50, 67, 489, 943, 1283 and 1449.

E. The unit shall be UL 1449, third edition listed as a transient voltage surge suppression unit.

F. Environmental Requirements

1. Operating temperature range shall be -40 degrees to +60 degrees C.
2. Operation shall be reliable in an environment with 5% to 95% non-condensing relative humidity.
3. The unit shall not generate audible noise greater than 35 dB at 3 feet from the unit.
4. No appreciable magnetic fields shall be generated. The unit shall be capable of use directly in computer rooms in any location without danger to data storage systems or devices.

G. Electrical Requirements

1. The nominal unit operating voltage and configuration shall be as indicated on the drawings.
2. The maximum continuous operating voltage of all suppression components utilized in the unit shall not be less than 115% of the facility's nominal operating voltage.
3. The operating frequency range of the unit shall be 47 to 63 Hertz.
4. The unit's primary mode of protection shall be line-to-neutral. The secondary modes of protection shall be line-to-ground and neutral-to-ground.
5. Based on ANSI/IEEE C62.41-1991's standard 8 x 20 microsecond current waveform, the maximum repetitive surge current capacity, in amps, of the unit shall be no less than 100 KA per mode.
6. The unit's published performance ratings shall be the UL 1449 Listed suppression ratings. The UL 1449 suppression rating shall be, for each mode of protection and system voltage as follows:

    a. L-L: 1500 Volts for 480Y/277 Volt, 3 phase, 4 wire systems, 700 Volts for 208Y/120 Volt, 3 phase, 4 wire systems and 240/120 Volt 1 phase, 3 wire systems.
    b. L-N: 800 Volts for 480Y/277 Volt 3 phase, 4 wire systems, 400 Volts for 208Y/120 Volt 3 phase, 4 wire systems and 240/120 Volt 1 phase, 3 wire systems.
    c. L-G: 1500 Volts for 480Y/277 Volt 3 phase, 4 wire systems, 700 Volts for 208Y/120 Volt 3 phase, 4 wire systems and 240/120 Volt 1 phase, 3 wire systems.
    d. N-G: 800 Volts for 480Y/277 Volt 3 phase, 4 wire systems, 400 Volts for 208Y/120 Volt 3 phase, 4 wire systems and 240/120 Volt 1 phase, 3 wire systems.

3. EXECUTION

3.1 GENERAL

A. Inspection: Installer must examine areas and conditions under which switchboards and components are to be installed and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

B. Coordinate with other work including electrical cabling and wiring, as necessary to interface installation of switchboards.

C. Tighten connections and terminals including screws and bolts, in accordance with equipment manufacturers published torque-tightening values for equipment connectors. Where manufacturers torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque's specified in UL Standard 486A.

D. Set all adjustable circuit breaker elements according to the coordination study submitted.

END OF SECTION 26 24 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 24 16 - PANELBOARDS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 specification sections, apply to the work of this Section.

B. This Section is a Division 26 "Basic Materials and Methods" section, and is a part of each Division 26 section making reference to panelboards specified herein.

1.2 DESCRIPTION OF WORK

A. Extent of panelboard and enclosure work, including cabinets and cutout boxes is indicated on the drawings and by schedules.

B. Types of panelboards and enclosures in this Section include the following:

1. Distribution Panels
2. Lighting and Appliance Panels

C. Refer to other Division 26 sections for cable/wire, connectors and electric raceway work required in conjunction with panelboards and enclosures; not work of this Section.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of panelboards and enclosures, of types, size and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer: A firm of at least three (3) years of successful installation experience on projects with electrical installation work similar to that required for this project.

1.4 REFERENCES

A. Special Use Markings: Provide panelboards, constructed for special use, with UL markings indicating that special type usage. Panels identified or shown on the drawings for use as main service entrance equipment shall be labeled at the factory with "SERVICE ENTRANCE" type UL label.

B. UL Compliance: Comply with applicable UL safety standards pertaining to panelboards, accessories, and enclosures. Provide units which have been UL listed and labeled. UL standards are as follows:

1. Panelboards - UL67
2. Cabinets and Boxes - UL50

C. NEC Compliance: Comply with the NEC as applicable to the installation of panelboards, cabinets, and cutout boxes.

D. NEMA Compliance: Comply with NEMA Stds. Pub. No. 250 "Enclosures for Electrical Equipment (1000 volt maximum)", Pub. No. 1 "Panelboards" and Pub. No. PB1.1, "Instruction for Safe Installation, Operation, and Maintenance of Panelboards Rates 600 Volts and Less".

E. NECA Compliance: Comply with NECA's "Standard of Installation".

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each panelboard required. Include data substantiating that units comply with specified requirements.

B. Shop Drawings: Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not limited to circuit breakers, fusible switches, fuses, ground fault circuit interrupters, and accessories.

C. Shop Drawings shall be submitted along with, and at the same time as the Coordination Study and Arc Flash Hazard Analysis study described in specification section 260573. All submitted section 262416 equipment shall match the equipment in the Coordination Study and Arc Flash Hazard Analysis study.

2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements provide products of one of the following:

1. Square D Company
2. General Electric
3. Cutler Hammer
4. Siemens

2.2 GENERAL

A. Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, and which are designed and constructed in accordance with published product information. Provide solderless lugs, or connectors, in the correct number and size for conductors on mains, on the load side of each branch, circuit, and on ground and neutral bars. Provide tin plated copper busses. Provide an insulated neutral bus and a bonded equipment ground bus mounted at the opposite end of the structure from the mains, and having numbered screw or lug terminals for connection of wires. Equip panels with the number of unit devices as required for a complete installation. Where more than one type of component meets the indicated requirements, selection is installer's option. Where types, sizes or ratings are not indicated, comply with NEC, UL and established industry standards for applications indicated.

B. Provide ground fault circuit interrupting type circuit breakers for all devices noted with a "GFI" subscript on the panelboard schedules for this project.

C. Provide UL listed HACR type circuit breakers for all devices which serve heating, ventilating, or air conditioning equipment.

D. Panelboards shall be provided with covers for surface or flush mounting as shown on the drawings, or as required for actual project conditions.

E. Panelboards shall be constructed for top or bottom feeder service, as required by actual project conditions.

F. All circuit breaker trip indications and metered values shall be displayed on the front of the panelboard after opening the hinged door without removal of any bolted covers.

2.3 LIGHTING AND APPLIANCE PANELS

A. Lighting and appliance panelboards shall be Square D type NQOB (or equal) 120/208 volt applications. All branch circuit breakers are to be quick-make, quick-break, trip indicating and common trip on all multi-pole breakers, and shall be bolt-on type. Plug in breakers are not allowed. Trip indication shall be clearly shown by breaker handle located between the "ON" and the "OFF" positions. Panelboards shall have distributed phase copper bussing throughout.

B. Review drawings and provide main circuit breaker type panels where indicated on the drawings. Additionally, provide main lug only type panels where indicated on the drawings.

C. Provide fully rated main circuit breaker or main lug only (see drawings) type panelboards where the short circuit rating of the complete panelboard assembly is determined by the lowest rated branch device. Provide panelboard interrupting ratings as noted on the drawings.

D. Lighting and appliance panels shall be 5.75” deep, maximum and shall have 6-inch minimum gutters. Fronts are to be complete with door in door hinge style and cylinder lock, with all locks

keyed alike. Fronts shall have adjustable trim clamps, directory frames, and shall be equipped with a typewritten directory that identifies each circuit breaker by number and the equipment that the breaker serves. One additional blank directory card for each panel shall be furnished to the Owner.

E. Two section panels (as required by Code) shall be equipped with boxes of equal dimensions.

F. Panelboards shall be Underwriters' Laboratory listed and shall bear the UL label. The size of the panelboard main disconnect device or main lugs, the rating and number of branch circuits, and the type of mounting shall be as shown on the drawings.

G. All factory installed devices shall be re-torqued prior to energizing.

2.4 DISTRIBUTION PANELS

A. Distribution panels shall be Square D I-Line (or equal) panels as indicated on the plans. Provide appropriate type of panels to meet specific project requirements. Panelboards shall have distributed phase copper bussing throughout.

B. Circuit breakers shall be as specified for lighting panels unless indicated otherwise. Power panels shall have combination card holder and name-plate and shall be equipped with typewritten directories that identify all loads served and all spare circuits. Provide a copper ground bus in all power panels.

C. Power panels shall be Underwriters' Laboratory approved and shall bear the UL label. Main lugs and gutters shall be suitable for copper and aluminum wire. The size of the panelboard main protective device or main lugs, the size, type and the number of branch circuits and the type of mounting shall be as shown on the drawings.

D. Review drawings and provide main circuit breaker type panels where indicated on the drawings. Additionally, provide main lug only type panels where indicated on the drawings.

E. Provide fully rated main circuit breaker or main lug only (see drawings) type panelboards where the short circuit rating of the complete panelboard assembly is determined by the lowest rated branch device. Provide panelboard interrupting ratings as noted on the drawings.

2.5 FEEDER PROTECTIVE DEVICES

1. The following paragraphs list the general feeder protective device requirements:

   a. Feeder protective devices as shown shall be molded case air circuit breakers, built, tested and UL labeled per UL 489.
   b. In general breakers with 200 ampere frames and above shall be Square D Powerpact or approved equivalent with solid-state trip complete with built in current

transformers, solid-state trip unit and flux transfer shunt trip. Breaker shall include a true RMS sensing electronic trip unit with; adjustable long time pickup, adjustable long time delay, adjustable short time pickup, adjustable short time delay, I2tin and I2tout, adjustable instantaneous pickup, and targets to show cause of breaker trip. Where ground fault trip function is used it shall be part of the circuit breaker electronic trip unit and include; adjustable pickup, adjustable delay, I2tin and I2tout

c. Solid state instantaneous element shall be continuously adjustable from approximately 4 to 8 times the trip rating, with short time adjustment from instantaneous to 10-cycle delay for coordination purposes. Provide short delay override feature providing for instantaneous tripping on high magnitude faults.

d. Molded case breakers shall have a minimum UL listed interrupting capacity as listed on the drawings.

e. For all circuit breakers rated 1200 Amps or more, provide circuit breaker with an energy reducing maintenance switch per NEC paragraph 240.87. Maintenance switch shall be a two position, lockable device with a locally mounted blue strobe beacon enabled when in maintenance mode. System shall have one spare set of contacts for future use. A label shall be provided for beacon stating “Breaker in Maintenance Mode When Flashing”. Alternative methods may be considered on a case by case basis.

2.6 CUSTOMER METERING

A. Where indicated on the drawings, provide digital electronic power meters with the following monitoring and metering capabilities:

1. Current, per phase and neutral.
2. Voltage, phase-to-phase and phase-to neutral.
3. Real power (kW), per phase and three-phase total.
4. Reactive power (kVAR), per phase and three phase total.
5. Apparent power (kVA), per phase and three phase total.
6. Power factor (true), per phase and three phase total.
7. Frequency.
8. Demand current, per phase and neutral, present and peak.
9. Real power demand (kWd), three phase total, present and peak.
10. Reactive power demand (kVARd), three phase total, present and peak.
11. Apparent power demand (kVAd), three phase total, present and peak.
12. Real energy (kWh), three phase total.
13. Reactive energy (kVARh), three phase total.
14. Apparent energy (kVAh) three phase total.
15. Energy accumulation modes, signed, absolute, energy in, energy out.
16. Total harmonic distortion (THD), voltage and current, per phase.
17. Date and time stamping, peak demands, power up/restart and resets.

A. Provide all necessary components and connections from electronic power meter to Owner’s Building Management System. Coordinate requirements and installation with the Owner’s control representatives.

B. The power meter shall be accurate to 0.25% of the reading plus 0.05% of the full scale for voltage and current sensing, and 0.5% of the reading plus 0.05% of the full scale for power and energy, accurate through the 31st harmonic.

C. Provide necessary current transformers to support current inputs to the power meter. Provide potential transformers, control power transformers, and fusing as required.

3. EXECUTION

3.1 INSTALLATION

A. General: Install panelboards and enclosures where indicated, in accordance with the manufacturers' written instructions, applicable requirements of the NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate the installation of panelboards and enclosures with cable and raceway installation work.

C. Provide all required electrical connections within the enclosure.

D. Fill out typewritten panelboard circuit directory cards upon completion of the installation work.

END OF SECTION 26 24 16

SECTION 26 25 50 – DUAL PURPOSE DOCKING STATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections apply to the work of this Section.

B. Division 26 "Basic Materials and Methods" sections apply to the work in this Section.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ETL/UL LISTED to 1008 Standards

C. UL 50 LISTED.

D. Comply with NFPA 70.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data including specifications, installation instructions, one line diagram, wiring diagram(s), and general recommendations for required dual purpose docking station.

1.4 GUARANTEE/WARRANTY

A. The equipment installed under this contract shall be left in proper working order.

B. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

PART 2. PRODUCTS

2.1 GENERATOR DOCKING STATION

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. TRYSTAR: Dual Purpose Generator Docking Station, DBDS-5

Or Equivalent by

2. ESL Power Systems
3. ASCO

2.2 GENERAL REQUIREMENTS

A. Docking station shall include 16 Series Camlok Panel Mounts for use as connection to Portable Generator and Temporary Load Bank

B. Entire package must be listed to ETL or UL 1008 Standards. UL listing of individual components is not acceptable.

C. Enclosures:

1. NEMA 3R rain-tight, Aluminum or 304 Stainless Steel

a. Pad-lockable front door shall include a hinged access plate at the bottom for entry of cables from portable generator or portable load bank. NEMA 3R integrity shall
b. be maintained with access plate open for cable entry.
c. Front and side through a front access panel shall be accessible for maintenance.
d. Top, side, and bottom through a front access panel shall be accessible for permanent cabling.

2. Finishes:

a. Paint after fabrication. Powder coated Hammertone Gray.

D. Phase, Neutral, and Ground Buses:

1. Material: Silver-plated Copper
2. Equipment Ground Bus: bonded to box.
3. Isolated Ground Bus: insulated from box.
4. Ground Bus: 50% of phase size.
5. Neutral Bus: Neutral bus rated 100 percent of phase bus.
6. Round edges on bus.

E. Temporary generator connectors shall be Camlok style mounted on gland plate.

1. Camlok shall be color coded according to system voltage

a. A phase – Black or Brown
b. B phase – Red or Orange

c. C phase – Blue or Yellow
d. N Neutral – White
e. G Ground – Green

F. Temporary load bank connectors shall be Camlok style mounted on gland plate.

1. Camlok shall be color coded according to system voltage

a. A phase – Black or Brown
b. B phase – Red or Orange
c. C phase – Blue or Yellow
d. G Ground – Green

G. Temporary connectors shall include protective flip lids to prevent accidental contact.

H. Permanent connectors shall be broad range set-screw type, located behind an aluminum barrier.

I. Short Circuit & Withstand Rating

1. Shall be minimum 65KAIC unless otherwise indicated on drawings.

J. Voltage & Amperage:

1. 480Y/277V, 3Ph and amperage as indicated on drawings.

K. Phase Rotation Monitor Device:

1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal.

L. Optional Breaker Disconnects as Indicated on Project Drawings and Manufacturer Submittal Drawings:

1. Must be UL 489 Listed Breaker
2. Breakers shall be removable for service and maintenance

M. Additional accessories shall be included in submittal drawings as follows:

1. Battery Charger Receptacle 20A, GFCI 125V
2. Kirk Key Door Interlock

PART 3. EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive Generator Docking Station for compliance with installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Surface, Flush or Base Mounted: Determined by Application

1. Install anchor bolts to elevations required for proper attachment to Generator Docking Station.

3.3 FIELD QUALITY CONTROL

A. Third Party Tests and Inspections to include the following:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

B. Prepare test and inspection reports, including a certified report that identifies Generator Docking Station and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 25 50

SECTION 26 27 26 - WIRING DEVICES

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

B. This section is a Division 26 "Basic Materials and Methods" section, and is a part of each Division 26 section making reference to wiring devices specified herein.

1.2 DESCRIPTION OF WORK

A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry, but not utilize electrical energy.

B. Types of electrical wiring devices in this Section include the following:

1. Receptacles
2. Switches
3. Wall Plates
4. Dimmer Controls

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of wiring devices of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less then 3 years.

B. Installer: Qualified with at least 2 years of successful installation experience on projects with electrical installation work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.

B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL listed and labeled.

C. NEMA Compliance: Comply with NEMA standards for general and specific purpose wiring devices.

D. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's data on electrical wiring devices.

2. PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following:

1. Pass and Seymour Corporation
2. Cooper
3. Hubbell, Inc.
4. Leviton, Inc.
5. Crouse Hinds
6. Lutron

2.2 WIRING DEVICES

A. General: Where shown on the drawings, furnish and install wiring devices indicated by the appropriate symbols. Unless otherwise noted, wiring devices shall be products of Pass and Seymour Corporation, or equal. Catalog numbers shown below are P & S hard use specification grade. Similar devices manufactured by Hubbell or Leviton shall be equally acceptable.

B. Switches: Branch circuit switches shall be flush tumbler type as follows:

1. Single Pole — CSB20AC1 Series - Gray
2. Two Pole — CSB20AC2 Series - Gray
3. Three-Way — CSB20AC3 Series - Gray
4. Four-Way — CSB20AC4 Series - Gray
5. Single Pole SW With Pilot — CSB20-AC1-RPL Series
6. LED Dimmer Switches: Provide dimmer switches capable of 0-10 Volt dimming of LED and fluorescent loads, Legrand Radiant series or engineer approved equal. Provide adequate number of conductors between dimmer switches and dimmed fixtures regardless of circuiting shown on drawings.
7. Switches fed by a generator circuit (standby or life safety) shall be the same as above but RED in color.
8. Where specific wiring devices are indicated on the drawings the device indicated on the drawings shall govern.

A. Occupancy Sensors/Switches, Time Switches, Lighting Control System

1. Reference Drawings for additional information.
2. All switches shall be gray in color if fed from a non-emergency panelboard. Switches fed by a generator circuit shall be RED in color.

2.3 RECEPTACLES

A. All receptacles shall be side and back wired, self-grounding of the type indicated on the drawings, or as follows. Catalog numbers shown below are Pass & Seymour specification grade unless otherwise indicated. Similar devices manufactured by Hubbell or Leviton shall be equally acceptable:

1.	Duplex Convenience Receptacles 20A-125V (Grounding Type)	CRB5362 Series-Gray
2.	Weatherproof Duplex Receptacles 20A-125V (Grounding Type)	CRB5362-Gray-WP Series- with Weatherproof Plate
3.	Duplex GFI Receptacle 20A-125V	2095 Series-Gray
4.	Weatherproof Duplex GFI Receptacle 20A-125 Volt	2097TRWR-Gray with WP Wall Plate
5.	Duplex USB Receptacle	TR5362USB-Gray
6.	Tamper Resistance Receptacle	TR63-Gray for Normal

7. All receptacles fed by a generator circuit shall be the same as above but RED in color.

2.4 PLATES

A. Furnish and install wall plates for all wiring devices. Where switches and/or receptacles are shown adjacent to each other, provide a common cover plate for each group of devices. Oversize plates are not acceptable.

1. Plates shall be Pass and Seymour Type 302 stainless steel.
2. Cover plates for all electrical devices shall be engraved with panel and circuit no. designation. Engraving shall be 1/8” high, block style letters, with black filler on front side of cover plates.
3. Weatherproof switch plates shall be Crouse Hinds DS185 type.
4. Weatherproof receptacle plates shall be Crouse Hinds WLRD1 type.
5. Weatherproof “In-Use” receptacle plates shall be Intermatic Extra-Duty Die-Cast Aluminum Series. Provide necessary number of gangs, mounting bases, inserts and gaskets. In-use covers shall be used in all wet location areas as defined by NEC 406.9(B)(1).

3. EXECUTION

3.1 INSTALLATION

A. Install wiring devices as indicated in compliance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices and other work.

C. Testing: Test wiring devices for electrical continuity of grounding connections and proper polarity. Test wiring devices to demonstrate compliance with requirements.

D. Where devices are installed on exposed fittings or boxes, the plates shall be galvanized and of a type designed to fit the box. Blank covers shall be installed on all boxes without devices or fixtures, of same type as installed on devices in the room or area.

E. All outlets shall be located as shown on the drawings, except that where practicable, outlets shall be located in center of panels or trim or otherwise symmetrically located to conform with existing structural layout. Outlets incorrectly installed shall be corrected. Damaged items or damaged finishes shall be repaired or replaced at no expense to the Owner.

F. Outlets shall be set plumb or horizontal and shall extend to the finished surface of the walls, ceiling or floor, as the case may be, without projecting beyond the same.

G. Receptacles, switches, etc., shown on wood trim, cases or other fixtures shall be installed symmetrically; and, where necessary, shall be set with the long dimensions of the plate horizontal, or ganged in tandem.

H. Where dimmer switches are shown adjacent to standard switches, both shall be installed in separate back boxes with adequate space between so that neither cover plate requires cutting.

I. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.

J. Where devices are shown mounted adjacent to one another on the drawings, provide multi-gang faceplates to cover all devices.

END OF SECTION 26 27 26

SECTION 26 29 13 - MOTOR CONTROLLERS

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to the work of this Section.

B. Division 26 "Basic Electrical Materials and Methods" section apply to the work specified in this Section.

C. Control Devices: Division 23 control devices such as aquastats, electric-pneumatic and pneumatic-electric switches, thermostats, freezestats, etc. are furnished and connected by the Division 23 Contractor unless specifically noted otherwise.

D. Motors: All motors shown on the drawings shall be furnished and set in place under the specific section in which the motor is specified.

E. Motor starters specified in other sections of this specification such as Division 23 shall be provided with power wiring by the Division 26 Contractor.

1.2 DESCRIPTION OF WORK

A. Extent of motor starter work is indicated by drawings and schedules.

B. Type of motor starters specified in this Section are as follows:

1. Full Voltage Non-Reversing Magnetic Starters
2. Reduced Voltage Starters
3. Manual Motor Starters
4. Remote Controls

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of motor starters of types, ratings and characteristics required, whose products have been in satisfactory operation in similar service for not less than five (5) years.

B. Firm with at least three (3) years of successful installation experience on projects utilizing motor starters similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with NEC requirements as applicable to wiring methods, construction, and installation of motor starters.

B. NFPA Compliance: Comply with applicable requirements of NFPA standard 70E "Standard for Electrical Safety Requirements for Employee Workplaces."

C. UL Compliance: Comply with applicable requirements of UL 486A "Wire, Connectors, and Soldering Lugs for Use with Copper Connectors," and UL 508 "Electrical Industrial Control Equipment" pertaining to the installation of motor starters. Provide motor starters and components which are UL listed and labeled.

D. IEEE Compliance: Comply with applicable requirements of IEEE Standard 241 "Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to motor starters.

E. NEMA Compliance: Comply with applicable requirements of NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub. No. 250, "Enclosures for Electrical Equipment (1000 volts Maximum)" pertaining to motor controllers/starters and enclosures.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's data on motor starters.

B. Provide shop drawings of equipment being provided and control diagrams for each motor starter.

2. PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the requirements, provide motor starters of one of the following:

1. Allen Bradley Co.
2. General Electric Co.
3. Siemens
4. Square D Co.

2.2 GENERAL

A. Except as otherwise indicated, provided motor starters and ancillary components which comply with the manufacturer's standard materials, and which are designed and constructed in accordance with published product information as required for a complete installation. Unless specifically indicated otherwise provide all power wiring, disconnects, starters, relays, hand-off-auto switches, pilot lights, motor connections, supports and all miscellaneous and necessary appurtenances required for a satisfactory and complete working system.

B. All devices in Animal Areas shall be NEMA 4/4X rated. Other locations shall have enclosure ratings as stated in this specification.

2.3 FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS

A. Provide magnetic starters for three phase motors. Motor starters shall be full voltage non-reversing across the line magnetic type rated in accordance with NEMA standard sizes and horsepower ratings. Magnetic starters shall not be less then NEMA size one.

1. Each starter shall have a removable hinged cover capable of being padlocked. Enclosures shall be NEMA 1 general purpose type unless indicated otherwise. Provide watertight and dust tight enclosures for units installed outside, or as indicated on the drawings. Starters shall be provided with double break silver alloy contacts. All contacts shall be replaceable without removing wiring or the starter from the enclosure.

B. Magnetic starters shall be provided with the following additional equipment:

1. Overload relays shall be an integral part of the motor starter. Overload relays shall have a minimum ±10 percent adjustment from the nominal heater rating. Heaters shall be available such that when used with the ±10 percent adjustment, a continuous selection of motor full load currents can be obtained through the size limitations of the starter. Overload relays shall be manual reset and field convertible from manual to automatic reset. Overload relays shall be melting alloy or bimetallic type. Thermal units shall be of one piece construction and interchangeable. The starter unit shall be inoperative if the thermal unit is removed. Provide 3 overload relays, one for each phase of the three phase starter.
2. Starters shall be suitable for the addition of at least three normally open and three normally closed auxiliary contacts. Provide a minimum of two normally open and two normally closed contacts unless additional contacts are scheduled on the drawings or required for proper control of the equipment.
3. In each magnetic starter provide cover mounted hand-off-auto selector switch complete with a manual overload reset button and a red "On" pilot light. Provide a control transformer with a secondary voltage of 120V, complete with primary overload and short circuit protection.
4. Time delay relays with time delay after energization shall be provided for starters indicated, or as required for proper control of equipment. Time delay feature shall be adjustable from 0 to 60 seconds and set as indicated on the drawings.

2.4 PART WINDING REDUCED VOLTAGE MANETIC STARTERS

A. Provide Allen-Bradley Bulletin 736 part-winding starters, closed-transition, magnetic, non-reversing, reduced-inrush, two-step type. Limit line current to a maximum of 65 percent of the locker rotor current. Coordinate and verify compatibility with the motor and driven equipment. Provide starter capable of interrupting 10 times motor full load rating.

B. Provide starters with the equipment listed in paragraph 2.3, B above.

C. Provide additional equipment for combination starters in accordance with paragraph 2.3, B above.

2.5 WYE-DELTA REDUCED VOLTAGE MAGNETIC STARTERS

A. Provide Allen-Bradley Bulletin 737 wye-delta starters, magnetic, non-reversing, reduced-inrush, closed-circuit transition type. Limit the inrush line current to a maximum of 35 percent of the locked rotor current. Coordinate and certify compatibility with the motor and driven equipment. Provide three thermal overload relays in series with each winding. Provide starter capable of interrupting 10 times motor full local rating.

B. Provide starters with the equipment listed in paragraph 2.3, B above.

2.6 AUTO-TRANSFORMER REDUCED VOLTAGE MAGNETIC STARTERS

A. Provide Allen-Bradley Bulletin 746 auto-Transformer starters, magnetic, non-reversing, reduced-inrush, closed-circuit transition type. Provide minimum tap of 65 percent for motors 30 hp or less, and 50 percent for motors in excess of 30 hp. Limit the inrush line current to a maximum of 43 percent and 25 percent respectively, of the locked rotor current. Provide thermal overload protection in each phase. Provide starter capable of interrupting 10 times motor full load rating.

B. Provide starters with the equipment listed in paragraph 2.3, B above.

2.7 FULL VOLTAGE NON-REVERSING COMBINATION STARTERS

A. Full voltage non-reversing combination starters shall be Square D Class 8538 (or equal) unless otherwise indicated. Provide additional equipment for combination starters in accordance with the requirements outlined in paragraph 2.3.2 above. Where combination starters are shown on the drawings, a separate starter and disconnect switch may be substituted at the Contractor's option, provided adequate space is available for the installation.

B. Provide fused disconnect switches with Class R type fuse rejection clips. If breakers are shown, provide breakers with a minimum of 22,000 RMS symmetrical amps interrupting capacity.

2.8 MANUAL MOTOR STARTERS

A. Thermal element type manual motor starters complete with melting alloy type thermal overload relays for single phase motors shall be Square D Class 2510. Provide overload relays sized in accordance with NEC requirements for the motor loads served.

B. Provide flush mounted units in finished areas and surface mounted units in unfinished areas. Starter shall have NEMA I general purpose enclosure, unless otherwise indicated, and be rated for the motor horsepower required.

2.9 REMOTE CONTROLS

A. Provide Square D standard duty oil-tight pushbuttons, pilot lights, and/or selector switches where indicated on the drawings, or wherever required for proper control of the equipment. Units shall be flush mounted in finished areas and surface mounted in unfinished areas.

3. EXECUTION

3.1 INSTALLATION

A. Install motor starters as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of the NEC, UL and NEMA Standards, to ensure that products fulfill requirements.

B. Coordinate with other work including motor and electrical wiring/cabling work as necessary to interface installation of motor starters with other work.

C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A.

D. Install fuses in fusible disconnect switches as required.

E. Adjusting and Cleaning: Inspect electrical starter's operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movements.

F. Field Quality Control: Subsequent to connecting wire/cables, energize motor starter circuitry and demonstrate functioning of equipment in accordance with specified requirements. Where necessary, correct malfunctioning units and retest to demonstrate compliance. Ensure that direction of rotation of each motor fulfills requirements.

END OF SECTION 26 29 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 29 23
VARIABLE FREQUENCY DRIVES

1. GENERAL

1.1 SECTION INCLUDES

A. Variable Frequency Drives for use on mechanical equipment including fans and pumps.

B. Exact horsepower and voltage requirements are as shown the Mechanical Equipment Schedules on the drawings.

C. The Contractor shall provide all labor, materials, tools, and equipment required to furnish, construct, and install motor starters, electrical power circuits, and other items and equipment as detailed on the Drawings and specified herein.

D. The Work shall include everything requisite and necessary to finish the Work properly, notwithstanding that every item of labor or materials or accessories required to make the installation complete may not be specifically mentioned.

E. The Work shall include, but shall not necessarily be limited to, the following:

1. Furnish and install VFDs as indicated on the Drawings.

1.2 REFERENCES.

A. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems; National Electrical Manufacturers Association.

B. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives; National Electrical Manufacturers Association.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.

D. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.

E. Institute of Electrical and Electronic Engineers (IEEE) Standard 519-1992, IEEE Guide for Harmonic Content and Control.

F. Underwriters laboratories UL508C

G. IEC 16800 Parts 1 and 2

H. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.3 SUBMITTALS.

A. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

C. Test Reports: Indicate field test and inspection procedures and test results.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Manufacturer's Field Reports: Indicate start-up inspection findings.

F. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

G. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.

H. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to mechanical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

I. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).

1. The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD’s shall include a minimum of 5% impedance reactors, no exceptions.

1.4 OPERATION AND MAINTENANCE DATA.

A. The manufacturer shall supply test results to confirm that the controller has been tested to substantiate designs according to applicable ANSI and NEMA standards. These tests shall verify not only the performance of the unit and integrated assembly, but also the suitability of the

enclosure venting and rigidity. In addition, unit shall be factory tested in accordance with ANSI standards. Manufacturer shall provide factory test report to be included with the operation and maintenance manuals shipped with the unit.

1.5 QUALIFICATIONS.

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience and with service facilities within 200 miles of Project.

C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 MAINTENANCE SERVICE.

A. Provide service and maintenance of controllers for one year from Date of Substantial Completion.

1.7 REGULATORY REQUIREMENTS.

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc.

C. FM P7825 - Approval Guide; Factory Mutual Research Corporation.

D. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association.

E. SSPC-Paint 15 - Steel Joist Shop Paint; Society for Protective Coatings (Part of Steel Structures Painting Manual, Vol. Two).

1.8 DELIVERY, STORAGE, AND HANDLING.

A. See Section 23 05 00.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers of variable frequency drives shall be limited to the following:

1. ABB Model ACH580
2. Toshiba Model Q9 Plus
3. Yaskawa Model HV600
4. Or approved equivalent. **Any other manufacturer must be submitted during bidding process. Provide list of differences between proposed manufacturer's equipment and equipment as specified.**

2.2 VARIABLE FREQUENCY DRIVES (VFDs)

A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.

1. Employ microprocessor-based inverter logic isolated from power circuits.
2. Employ pulse-width-modulated inverter system.
3. Include a DC link reactor for reduction of harmonic distortion.
4. The controller, and all associated components, shall be supplied by a single vendor.
5. The controller will be operating a variable volume fan motor, or water pump motor for HVAC application.
6. System voltage shall be indicated on front of ASD, using minimum of 1-inch high letters.

B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places regularly open to the public. No disconnects in VFD cabinet. Disconnect must be in separate enclosure.

2.3 OPERATING REQUIREMENTS

A. Rated Input Voltage for motors rated below 40 HP: 200 volts, three phase, 60 Hertz, with a voltage tolerance of +/- 10% and a frequency tolerance of +/- 2 Hz.

B. Rated Output: Output frequency shall vary between 0.1 Hz and 400 Hz. Frequency resolution shall be 0.01 Hz digital and 0.03 Hz analog with an accuracy of +/-0.2% of maximum frequency at 25 degrees Celsius. Maximum voltage frequency shall be adjustable from 25 Hz to 400 Hz. Voltage boost shall be adjustable from 0% to 30% with starting frequency adjustable from 0 Hz to 10 Hz. The output current shall be 100% continuous and 110% for 60 seconds, based on NEC table 430-150 (Full-Load Current, Three-Phase Alternating Current Motors) for 200 volts or 460 volts.

C. The controller shall contain three critical frequency jump points with individual bandwidth. Upper and lower frequency limits shall be capable of being varied.

D. The PWM carrier frequency shall be adjustable from 5000 Hz to 15000 Hz.

E. The drive shall contain two separate acceleration/deceleration times (0.1 to 6000 seconds) with a choice of linear, S, or C curves. The drive shall have a standard dynamic electric braking for motors rated 30 HP or below. The drive shall restart into a rotating motor by sensing the coasting motor speed and matching that frequency. The drive shall have adjustable soft stall (10%-150%) and adjustable electronic overload protection (10%-100%).

F. The drive shall have external fault input, be capable of re-setting faults remotely and locally.

G. Input Signal:

1. 0 to 10 v DC
2. 0 to 5 v DC
3. 4 to 20 mA DC

H. Manual bypass is not required on VFD unless indicated on bid documents.

2.4 COMPONENTS

A. Display: Provide integral digital display to indicate output voltage, output frequency, and output current, output power (kw), and motor RPM.

2.5 HARMONICS

A. Reference IEEE 519-2014 Total Demand Distortion (TDD) limit at the PCC (point of common coupling). VFD supplier must provide harmonic calculations to show compliance with IEEE 519-2014.

B. VFDs provided shall have 5% reactor (or DC choke) as integral to the VFD.

C. Additional harmonic mitigation equipment in order to achieve compliance with IEEE 519-2014 shall include, but not be limited to, the following:

1. 5% THD passive harmonic filter with contactor. The passive harmonic filter shall be mounted in the same enclosure as the drive.
2. A capacitor drop-out contactor shall be included to open at reduced loads.

D. Active front end “ULH” technology the incorporates DC bus capacitors, IGBTs, LCL filtering, and LCL contactor. Maintain unity power factor at full load while complying with IEEE 519-2014. VFDs that do not utilize this technology are not allowed.

E. VFDs that cannot produce an output voltage that is equal to the motor nameplate voltage while operating at full speed are not allowed

3. EXECUTION

3.1 INSTALLATION

A. Install in accordance with NEMA ICS 7.1, manufacturer's instructions, and per drawings.

B. Tighten accessible connections and mechanical fasteners after placing controller.

C. Provide engraved plastic nameplates; refer to Division 26 for product requirements and location.

D. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place in clear plastic holder.

E. When remote service disconnect is required, provide with auxiliary contacts hardwired to VFD safety circuit to shut down VFD, if disconnect is opened.

F. Install units on floor mounted uni-strut frames or on housekeeping pads (pads to be used for larger, free standing units only).

G. Do not install units such that their supports or the units themselves are in direct contact with vibrating equipment (i.e., fans, pumps, compressors, etc.).

H. Do not install units directly below mechanical piping, expansion tanks, etc.

I. The service disconnect switch must be installed on the line side of the VFD. The disconnect must be in a separate enclosure from the VFD. If conditions do not allow this disconnect to be located near the motor within NEC requirements, then a second remote disconnect may be required at the motor. Consult the project manager or University Engineer if this condition arises. All remote disconnects must be provided with auxiliary contacts hardwired to VFD safety circuit to shut down VFD when disconnect is opened. This may affect warranty on the drive so every attempt should be taken to install it per these design guidelines.

J. If a single VFD is controlling multiple fans in an air handling unit then overload protection on each fan must be provided. No more than 4 fans shall be connected to a single VFD.

K. The ground wire should be of the same size as the power conductors from the motor to the VFD and from the VFD to the source.

3.2 PRODUCT SUPPORT

A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line shall be available.

B. A computer based training shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

3.3 FIELD QUALITY CONTROL

A. Prior to initial energization, provide the service of the manufacturer's field representative to prepare and start controllers

3.4 WARRANTY

A. Manufacturer shall guarantee in writing one (2) years on site parts and labor warranty.

3.5 MAINTENANCE

A. Furnish two extra of each air filter.

B. Provide service and maintenance of controllers for one year from Date of Substantial Completion

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 32 13 – ELECTRICAL EMERGENCY STANDBY POWER SYSTEM GENERATOR SET

1. GENERAL

1.1 SCOPE

A. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.

B. Provide factory test, startup by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.

C. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

1.2 CODES AND STANDARDS

A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards.

1. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
2. NFPA37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
3. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
4. NFPA99 – Essential Electrical Systems for Health Care Facilities
5. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.

B. The generator set and supplied accessories shall meet the requirements of the following standards:

1. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.
2. UL142 – Sub-base Tanks
3. UL1236 – Battery Chargers
4. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

C. The control system for the generator set shall comply with the following requirements.

1. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
2. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
3. FCC Part 15, Subpart B.
4. IEC8528 part 4. Control Systems for Generator Sets
5. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
6. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
7. UL1236 –Battery Chargers.

D. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.3 ACCEPTABLE MANUFACTURERS

A. Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on generator sets manufactured by Cummins Power Generation with microprocessor-based controls. Equivalent systems and equipment provided by, Kohler, Caterpillar, MTU or Generac are acceptable. Equipment by other suppliers that meets the requirement of this specification is acceptable, if approved not less than 10 days before scheduled bid date. Proposals must include a line by line compliance statement based on this specification.

2. PRODUCTS

2.1 GENERATOR SET

A. Ratings

1. The generator set shall operate at 1800 rpm and at a voltage of: **480** Volts AC, Three phase, 4-wire, 60 hertz.
2. The generator set shall be rated at **450 kW, 563 kVA** at 0.8 PF, Standby rating, based on site conditions of: Altitude 758 ft. ambient temperatures up to 104 degrees F.
3. The generator set rating shall be based on emergency standby service.

B. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
3. The diesel engine-generator set shall accept a single step load of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

4. Motor starting capability shall be a minimum of **1766kVA**. The generator set shall be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified kVA load at near zero power factor applied to the generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 25%**.**
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples. Telephone influence factor shall be less than 40.
6. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.

C. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. All active control components shall be installed within a UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

D. Connections

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

2.2 ENGINE AND ENGINE EQUIPMENT

A. The engine shall be diesel, 4 cycle, radiator and fan cooled. Minimum displacement shall be **793** cubic inches, with 6 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:

1. An electronic governor system shall provide automatic isochronous frequency regulation. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed. The governing system shall include a programmable warm up at idle and cooldown at idle function.

While operating in idle state, the control system shall disable the alternator excitation system.

2. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the alternator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H2O restriction. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental contact.
3. Electric starter capable of three complete cranking cycles without overheat.
4. Positive displacement, mechanical, full pressure, lubricating oil pump.
5. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
6. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
7. Replaceable dry element air cleaner with restriction indicator.
8. Flexible supply and return fuel lines.
9. Engine mounted battery charging alternator, 35-ampere minimum, and solid-state voltage regulator.
10. Coolant heater

    a. Engine mounted, thermostatically controlled, coolant heater. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
    b. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall provisions to isolate the heater for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
    c. The coolant heater shall be provided with a DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system. Provide a circuit for the coolant heater sized in accordance with NEC requirements (circuit breaker, wire and conduit), and fed from the nearest standby emergency panelboard. Route circuit from panelboard to heater underground, buried a minimum of 42” below finished grade.
    d. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104F (40C) in a 40F (4C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

11. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.
12. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40F ambient temperature when fully charged.
13. A UL listed/CSA certified 10 amp voltage regulated battery charger shall be provided for each engine-generator set. The charger may be located in an automatic transfer switch, or may be wall mounted, at the discretion of the installer. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:

    a. Loss of AC power - red light
    b. Low battery voltage - red light
    c. High battery voltage - red light
    d. Power ON - green light (no relay contact)

2.3 AC GENERATOR

A. Charger shall include an Analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses.

B. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees Centigrade.

C. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

D. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

E. The sub-transient reactance of the alternator shall not exceed 15 percent, based on the standby rating of the generator set.

2.4 GENERATOR SET CONTROL

A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set.

The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

B. The control shall be mounted on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

C. The generator set mounted control shall include the following features and functions:

1. Control Switches

a. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
b. EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
c. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
d. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

2. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:

a. Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.
b. Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 1% at rated output. Only digital metering shall be required.
c. The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
d. The control system shall log total number of operating hours, total kWH, and total control on hours, as well as total values since reset.

3. Generator Set Alarm and Status Display.

   a. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:

      1) The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the genset. They shall also be configurable for color, and control action (status, warning, or shutdown).
      2) The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.
      3) The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
      4) The control shall include an amber common warning indication lamp.

   b. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:

      1) low oil pressure (warning)
      2) low oil pressure (shutdown)
      3) oil pressure sender failure (warning)
      4) low coolant temperature (warning)
      5) high coolant temperature (warning)
      6) high coolant temperature (shutdown)
      7) high oil temperature (warning)
      8) engine temperature sender failure (warning)
      9) low coolant level (warning)
      10) fail to crank (shutdown)
      11) fail to start/overcrank (shutdown)
      12) overspeed (shutdown)
      13) low DC voltage (warning)
      14) high DC voltage (warning)
      15) weak battery (warning)
      16) low fuel-daytank (warning)
      17) high AC voltage (shutdown)
      18) low AC voltage (shutdown)
      19) under frequency (shutdown)
      20) over current (warning)
      21) over current (shutdown)
      22) short circuit (shutdown)
      23) over load (warning)

24) emergency stop (shutdown)
25) (4) configurable conditions

c. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

D. Engine Status Monitoring

1. The following information shall be available from a digital status panel on the generator set control:

a. engine oil pressure (psi or kPA)
b. engine coolant temperature (degrees F or C)
c. engine oil temperature (degrees F or C)
d. engine speed (rpm)
e. number of hours of operation (hours)
f. number of start attempts
g. battery voltage (DC volts)

2. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

E. Engine Control Functions

1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
2. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

F. Alternator Control Functions:

1. The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase line to neutral RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
2. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.
3. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.
4. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
5. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

G. Other Control Functions

1. The generator set shall be provided with a network communication module to allow Modbus RTU or Native BACNet communications with the generator set control by remote devices. The control shall communicate all engine and alternator data, and allow starting and stopping of the generator set via the network in both test and emergency modes.

2. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

H. Control Interfaces for Remote Monitoring:

1. The control system shall provide four programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. The relays shall be configured to indicate: (1) generator set operating at rated voltage and frequency, (2) common warning, (3) common shutdown, (4) load shed command.
2. A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
3. A fused 10 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
4. **The control shall be provided with a Modbus RTU or Native BACNet communication network interface as described elsewhere in this specification and shown on the drawings. Coordinate exact requirements with BMS integrator.**

2.5 OTHER EQUIPMENT TO BE PROVIDED WITH THE GENERATOR SET

A. Provide and install a 20-light LED type remote alarm annunciator with horn, flush mounted in wall at location shown on plans. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems for the local generator control panel. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2. The interconnecting wiring between the annunciator and other system components shall be monitored and failure of the interconnection between components shall be displayed on the annunciator panel.

B. The annunciator shall include the following alarm labels, audible annunciation features, and lamp colors:

Condition	Lamp Color	Audible Alarm
Normal Power (to Loads)	Green	No
Genset Supplying Load	Amber	No
Genset Running	Green	No
Not in Auto	Red (Flashing)	Yes
High Battery Voltage	Red	Yes

Low Battery Voltage	Red	Yes
Charger AC Failure	Red	Yes
Fail to Start	Red	Yes
Low Engine Temperature	Amber	Yes
Pre-High Engine Temperature	Amber	Yes
High Engine Temperature	Red	Yes
Pre-Low Oil Pressure	Amber	Yes
Low Oil Pressure	Red	Yes
Overspeed	Red	Yes
Low Coolant Level	Amber	Yes
Low Fuel Level	Amber	Yes
Network OK	Green	Yes
(4) Spares	Configurable	Configurable

Low battery voltage lamp shall also be lighted for low cranking voltage or weak battery alarm.

C. The generator set shall be provided with a unit mounted main line circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate electronic trip that operates to protect the alternator under all overcurrent conditions and selectively coordinates with emergency electrical distribution system. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

D. Outdoor Weather-Protective Enclosure

1. The generator set shall be provided with an outdoor enclosure, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure, and sub-base fuel tank shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100F. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable, and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

2. The enclosure shall provide sound attenuation so generator set has a maximum of 79dB at 20 ft. from the enclosure at rated output.

3. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:

a. Primer thickness, 0.5-2.0 mils. Top coat thickness, 0.8-1.2 mils.

b. Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall exceed 50%.
c. Crosshatch adhesion, per ASTM D3359-93, 4B-5B.
d. Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.
e. Salt Spray, per ASTM B117-90, 1000+ hours.
f. Humidity, per ASTM D2247-92, 1000+ hours.
g. Water Soak, per ASTM D2247-92, 1000+ hours.

4. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
5. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.
6. The enclosure shall include the following maintenance provisions:

a. Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves
b. External radiator fill provision.

E. Provide a sub-base fuel tank for the generator set, sized to allow for full load operation of the generator set for **24 hours**. The sub-base fuel tank shall be UL142 listed and labeled. Installation shall be in compliance to NFPA37. The fuel tank shall be a double-walled, steel construction and include the following features:

1. Emergency tank and basin vents.
2. Mechanical level gauge.
3. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL2200 and NFPA 37 requirements.
4. Leak detection provisions, wired to the generator set control for local and remote alarm indication.
5. High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level
6. Basin drain.
7. Integral lifting provisions.

3. OPERATION

3.1 SEQUENCE OF OPERATION

A. Generator set shall start on receipt of a start signal from automatic transfer switches. The start signal shall be via hardwired connection to the generator set control.

B. The generator set shall complete a time delay start period as programmed into the control.

C. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:

D. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate “fail to crank” shutdown.

E. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.

F. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.

G. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous state.

H. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.

I. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.

J. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

4. OTHER REQUIREMENTS

4.1 SUBMITTALS

A. Within 10 days after award of contract, provide six sets of the following information for review:

1. Manufacturer’s product literature and performance data, sufficient to verify compliance to specification requirements.
2. A paragraph by paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
3. Manufacturer's certification of prototype testing.
4. Manufacturer's published warranty documents.
5. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
6. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
7. Manufacturer's installation instructions.

4.2 FACTORY TESTING

A. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.

B. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel expenses will be the responsibility of the owner and consulting engineer. Supplier is responsible to provide two weeks notice for testing.

C. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

4.3 INSTALLATION

A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer’s instructions and seismic requirements of the site.

D. Equipment shall be initially started and operated by representatives of the manufacturer.

E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

4.4 ON-SITE ACCEPTANCE TEST

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.

B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a

resistive load bank and make connections for full load test, if necessary. Additionally, a 24 hour run-time test shall be performed at standby rated load. Provide load bank connection for 24 hour test at rated load.

C. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

4.5 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

4.6 SERVICE AND SUPPORT

A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

4.7 WARRANTY

A. The generator set and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 26 32 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 36 23 – AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install automatic **open transition transfer & bypass-isolation switch** (ATS/BPS) system(s) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All automatic transfer & bypass-isolation switches and controllers shall be the products of the same manufacturer.

B. The ATS/BPS shall transfer the load in open transition (break-before-make) mode. Switch shall be provided with all necessary programming, accessories, adjustable settings, and source monitoring required for open transition.

C. The ATS/BPS shall not require rear access. Access for installation and maintenance shall be from front only. As required, provide bottom conduit entry wireway/pullbox on the side of the ATS/BPS to allow for entry of conduit from below the slab. Wireway/pullbox shall be provided by and manufactured by the ATS/BPS manufacturer.

1.2 CODES AND STANDARDS

A. The automatic transfer switches and controls shall conform to the requirements of:

1. UL 1008 - Standard for Transfer Switch Equipment
2. CSA certified to CSA 22.2 No 178 – 1978 Automatic Transfer Switches
3. IEC 60947-6-1 Low-voltage Switchgear and Controlgear; Multifunction equipment; Automatic Transfer Switching Equipment
4. NFPA 70 - National Electrical Code
5. NFPA 99 - Essential Electrical Systems for Health Care Facilities
6. NFPA 110 - Emergency and Standby Power Systems
7. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
8. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
9. International Standards Organization ISO 9001:2008
10. UL 508 Industrial Control Equipment

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s data and installation instructions for electrical power transfer switches.

B. Shop Drawings: Submit ½"=1'-0" scale layout drawings of electrical generator and transfer switches showing accurately scaled equipment locations, housekeeping pad size, location and spatial relationships to associated electrical equipment in proximity.

A. Wiring Diagrams: Submit wiring diagrams for electrical transfer switches, and associated control devices showing connections to prime and alternate power sources, electrical load, and equipment components. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

1.4 ACCEPTABLE MANUFACTURERS

A. Automatic open transition transfer & bypass-isolation switches shall be ASCO 7000 Series or approved equivalent. Equivalent equipment by Cummins or Russ Electric is acceptable. Any alternate shall be submitted for approval to the consulting engineer at least 10 days prior to bid. Alternate bids must list any deviations from this specification.

PART 2. PRODUCTS

2.1 MECHANICALLY HELD TRANSFER SWITCH

A. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.

B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.

C. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

D. All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 800 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

G. Where neutral conductors must be switched as shown on the plans, the AS shall be provided with fully rated overlapping neutral transfer contacts. The neutrals of the normal and emergency power sources shall be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to which the transfer is being made. The overlapping neutral contacts shall not overlap for a period greater than 100 milliseconds. Neutral switching contacts which do not overlap are not acceptable.

H. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.2 BYPASS-ISOLATION SWITCH

A. A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.

B. Power interconnections shall be silver-plated copper bus bar. The only field installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control interwiring shall be provided with disconnect plugs.

C. Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door. Designs requiring insertion of loose operating handles or opening of the enclosure door to operate are not acceptable.

D. Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). Designs which disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.

E. The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.

F. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.

G. Designs requiring operation of key interlocks for bypass isolation or ATSs which cannot be completely withdrawn when isolated are not acceptable.

2.3 MICROPROCESSOR CONTROLLER

A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to plus or minus 1% of nominal voltage. Frequency sensing shall be accurate to plus or minus 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

D. All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. EN 55011:1991 Emission standard - Group 1, Class A
2. EN 50082-2:1995 Generic immunity standard, from which:
3. EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity
4. ENV 50140:1993 Radiated Electro-Magnetic field immunity
5. EN 61000-4-4:1995 Electrical fast transient (EFT) immunity
6. EN 61000-4-5:1995 Surge transient immunity
7. EN 61000-4-6:1996 Conducted Radio-Frequency field immunity

2.4 ENCLOSURE

A. The ATS/BPS shall be furnished in a Type 1 enclosure unless otherwise shown on the plans.

B. All standard and optional door-mounted switches and pilot lights shall be 16- mm industrial grade type or equivalent for easy viewing & replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.

PART 3. OPERATION

3.1 CONTROLLER DISPLAY AND KEYPAD

A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

1. Nominal line voltage and frequency
2. Single or three phase sensing
3. Operating parameter protection
4. Transfer operating mode configuration

(**Open transition**, Closed transition or Delayed transition)

All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

3.2 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout / Trip	Pickup / Reset
Undervoltage	N&E,3PH	70 to 98%	85 to 100%
Overvoltage	N&E,3PH	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

B. Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20 degrees C to 60 degrees C.

C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

D. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

E. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

F. The controller shall include a user selectable algorithm to prevent repeated transfer cycling to a source on an installation which experiences primary side, single phase failures on a Grounded Wye – Grounded Wye transformer which regenerates voltage when unloaded. The algorithm shall also inhibit retransfer to the normal (utility) source upon detection of a single phasing condition until a dedicated timer expires, the alternate source fails, or the normal source fails completely and is restored during this time delay period. The time delays associated with this feature shall be adjustable by the user through the controller keypad and LCD.

3.3 TIME DELAYS

A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

1. Prior to transfer only.
2. Prior to and after transfer.
3. Normal to emergency only.
4. Emergency to normal only.
5. Normal to emergency and emergency to normal.
6. All transfer conditions or only when both sources are available.

F. The controller shall also include the following built-in time delays for optional Closed Transition and Delayed Transition operation:

1. 1 to 5 minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.

2. 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.
3. 0 to 5 minute time delay for the load disconnect position for delayed transition operation.

G. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

H. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

3.4 ADDITIONAL FEATURES

A. A three position momentary-type test switch shall be provided for the *test / automatic / reset* modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.

B. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.

D. LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

E. LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

THE FOLLOWING FEATURES SHALL BE BUILT-IN TO THE CONTROLLER, BUT CAPABLE OF BEING ACTIVATED THROUGH KEYPAD PROGRAMMING OR THE SERIAL PORT ONLY WHEN REQUIRED BY THE USER:

F. Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

G. An Inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO Feature 27.

H. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

I. Engine Exerciser - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:

1. Enable or disable the routine.
2. Enable or disable transfer of the load during routine.
3. Set the start time, .
   - time of day
   - day of week
   - week of month (1st, 2nd, 3rd, 4th, alternate or every)
4. Set the duration of the run.
5. At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

THE FOLLOWING FEATURE SHALL BE BUILT - INTO THE CONTROLLER, BUT CAPABLE OF BEING ACTIVATED THROUGH KEYPAD PROGRAMMING OR THE COMMUNICATIONS INTERFACE PORT.

Note: The transfer switch will operate in a non-automatic mode with this feature activated.

J. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

K. System Status - The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,

NORMAL FAILED
LOAD ON NORMAL
TD Normal to Emerg
2min15s

Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.

L. Self Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

M. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non- volatile memory:

1. Event Logging

   a. Data and time and reason for transfer normal to emergency.
   b. Data and time and reason for transfer emergency to normal.
   c. Data and time and reason for engine start.
   d. Data and time engine stopped.
   e. Data and time emergency source available.
   f. Data and time emergency source not available.

2. Statistical Data

   a. Total number of transfers.
   b. Total number of transfers due to source failure.
   c. Total number of days controller is energized.
   d. Total number of hours both normal and emergency sources are available.

N. Communications Module – Shall provide remote interface module to support monitoring of vendor's transfer switch, controller and optional power meter. Module shall provide status, analog parameters, event logs, equipment settings & configurations over embedded webpage and open protocol. Features shall include:

1. Email notifications and SNMP traps of selectable events and alarms may be sent to a mobile device or PC.
2. Modbus TCP/IP, SNMP, HTTP, SMTP open protocols shall be simultaneously supported.
3. Web app interface requiring user credentials to monitor and control the transfer switch supporting modern smart phones, tablets and PC browsers. User will be able to view the dynamic one-line; ATS controls status, alarms, metering, event logging as well as settings.
4. Secure access shall be provided by requiring credentials for a minimum of 3 user privilege levels to the web app, monitor (view only), control (view and control) and administrator (view, control and change settings). 128-Bit AES encryption standard shall be supported for all means of connectivity.
5. Shall allow for the initiating of transfers, retransfers, bypassing of active timers and the activating/deactivating of engine start signal shall be available over the embedded webpage and to the transfer switch vendor's monitoring equipment.
6. An event log displaying a minimum of ninety-nine (300) events shall be viewable and printable from the embedded webpages and accessible from supported open protocols.

7. Four (4) 100 Mbps Ethernet copper RJ-45 ports, five (2) serial ports, Termination dip-switches and LEDs for diagnostics.
8. DIN rail mountable.

This option shall be equivalent to ASCO accessory 72EE2

O. External DC Power Supply – An optional provision shall be available to connect an external 24 VDC power supply to allow the LCD and the door mounted control indicators to remain functional when both power sources are dead. This option shall be equivalent to ASCO accessory 1G.

P. The ATS shall be provided with a Modbus RTU or Native BACNet communication network interface module for communication of transfer switch alarms/status. Coordinate exact requirements with BMS integrator.

PART 4. ADDITIONAL REQUIREMENTS

4.1 WITHSTAND AND CLOSING RATINGS

A. The ATS/BPS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS/BPS terminals with the type of overcurrent protection shown on the plans.

B. The ATS/BPS shall be UL listed in accordance with UL 1008 and be labeled in accordance with .025 and .050 seconds, time-based ratings, or appropriate short time rating(s) as applicable. ATS/BPSs which are not tested and labeled with.025 and.050 seconds time-based rating(s) or appropriate short time rating(s) and have series, or specific breaker ratings only, are not acceptable.

4.2 TESTS AND CERTIFICATION

A. The complete ATS/BPS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

B. The ATS/BPS manufacturer shall be certified to ISO 9001:2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001:2008

4.3 SERVICE REPRESENTATION

A. The ATS/BPS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

4.4 WARRANTY

A. Equipment shall be warranted for a period of not less than 3 years from the date of commissioning against defects in materials and workmanship.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 26 36 23

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 41 00 – LIGHTNING PROTECTION SYSTEM

PART 1. GENERAL

1.1 SUMMARY

A. The existing portion of the Nextgen Center of Excellence for Influenza Research building has an existing lightning protection system currently installed. Expand the existing system to fully cover the new construction portion of the building addition. The new portion of the lightning protection system shall fully integrate with and tie into the existing system so as to provide full protection of the building. The design of this system is to be in strict accordance with this section of the specifications and all contract drawings that apply.

B. The lightning protection system shall be designed and installed by a firm actively engaged in the installation of Underwriters Laboratories Inc. (UL) Master Labeled Lightning Protection Systems and shall be so listed by Underwriters Laboratories Inc. The completed system shall comply with the latest editions of Underwriters Laboratories Inc. “Installation Requirements for Lightning Protection Systems, UL96A” and of the National Fire Protection Association’s “NFPA® 780, Standard for the Installation of Lightning Protection Systems”. The system shall be physically inspected by UL and the Master Label® Certificate of Inspection shall be provided to the building owner and made available for viewing on the UL website, https://lps.ul.com.

C. The work covered under this section of the specification consists of furnishing labor, materials and services required for the completion of a functional and unobtrusive lightning protection system approved by the architect, engineer and Underwriters Laboratories Inc.

D. System designs shall be completely integrated with the architectural design of the facility, and shall be reviewed by the Architect/Engineer prior to installation. The lightning protection system installation in shall be fully coordinated with all other trades.

1.2 STANDARDS

A. The completed lightning protection system shall comply with the latest issue of the following standards which form a part of this specification. Where conflict occur between the two standards, the requirements of NFPA®780 shall apply.

1. NFPA® 780, Standard for the Installation of Lightning Protection Systems.
2. UL 96A, Installation Requirements for Lightning Protection Systems.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s descriptive and technical literature and catalog cuts.

B. Shop Drawings: Installation shop drawings shall be submitted to the Architect and Engineer for coordination with other trades and approval prior to start of the installation. Shop drawings are to show the extent of the system layout designed specifically for the building(s) or structures included in the contract drawings along with installation details of the products to be used in the installation.

1.4 QUALITY ASSURANCE

A. The installing contractor shall apply for inspection of the completed system by UL field representatives. The system is to be inspected by Underwriters Laboratories Inc, or other ANSI certified testing agency for compliance with NFPA® 780. The system shall be without deviation and the UL field representative will issue a UL Master Label® Certificate of Inspection for Lightning Protection Systems or Letter of Findings at completion of the installation, as indicated in section 3.04 below.

B. Manufacturer: Company specializing in lightning protection equipment with a minimum of five years of documented experience.

C. System Designer: Company specializing in the design of lightning protection systems with a minimum of five years of documented experience.

D. Installer: Authorized installer of system manufacturer with a minimum of five years of documented experience.

PART 2. PRODUCTS

2.1 MATERIALS

A. All materials used in the installation shall be new and shall comply in weight, size and composition as required by UL 96A and NFPA® 780 and shall be labeled or listed by Underwriters Laboratories Inc. for use in lightning protection systems. The system furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection equipment. The manufacturer shall be listed by UL as a manufacturer of lightning protection components.

2.2 ACCEPTABLE MANUFACTURERS

A. Harger Lightning & Grounding.

B. National Lightning Protection Corporation.

C. Robbins Lightning Protection Company.

D. Thompson Lightning Protection, Inc.

E. Preferred Lightning Protection.

2.3 MATERIAL REQUIREMENTS

A. Class I materials shall be used on structures or portions of structures that do not exceed 75 feet in height above grade level. Class II materials shall be used on structures that exceed 75 feet in height above grade.

B. Copper materials shall not be mounted on aluminum, Galvalume®, galvanized steel or zinc surfaces. This includes those materials that have been painted.

C. Aluminum materials shall not come into contact with earth or where rapid deterioration is possible. Aluminum materials shall not come into contact with copper surfaces or where exposed to runoff from copper surfaces. Aluminum materials shall not be attached to surfaces covered with alkaline-based paint, embedded in concrete or masonry, or installed in a location subject to excessive moisture.

2.4 AIR TERMINALS

A. Air terminals shall extend a minimum of ten inches above the object or area they are to protect. Air terminals shall be located at intervals not exceeding 20’-0” along ridges of pitched roofs and along the perimeter of flat or gently sloping roofs (flat or gently sloping roofs include roofs that have a pitch less than 3:12). Flat or gently sloping roofs exceeding 50’-0” in width shall be provided with additional air terminals located at intervals not exceeding 50’. Air terminals shall be located within two feet of the ends of the ridges, roof edges and outside corners of protected areas.

B. Air terminals shall be installed on stacks, flues, mechanical units and other objects not located within a zone of protection. Permanent metal objects on the structure having an exposed metal thickness 3/16” or greater may be substituted for air terminals and shall connected to the lightning protection system as required by the specified standards using main size conductor and bonding plates having a minimum of 3 square inches of surface contact area.

C. Air terminal bases shall be securely fastened to the structure in accordance with the specified standards. Fasteners may include stainless steel screws, bolts, nails, anchors or adhesive. Adhesive shall be compatible with the surface on which it is used. Any protective sheets or pads that may be required by the roofing manufacturer shall be furnished and installed by the roofing contractor.

D. Main conductors shall be sized as Class I or Class II materials in accordance with the specified standards. Conductors shall provide a two way, horizontal or downward path from each strike or air terminal to connections to the lightning protection ground electrode system. Conductors shall be free of excessive splices and no bend of a conductor shall form an included angle of less than 90 degrees nor have a radius of bend less than 8 inches.

E. Conductors shall be securely fastened to the structure on which they are placed at intervals not exceeding 3 feet. Fasteners shall be of the same material or of a material equally resistant to corrosion as that of the conductor. Any protective sheets or pads that may be required by the roofing manufacturer shall be furnished and installed by the roofing contractor.

F. Connector fittings shall be listed for the purpose and of the same material as the conductor or of electrolytically compatible materials.

G. Down conductors shall be sized as Class I or Class II materials in accordance with the specified standards. Class II conductors from a higher portion of a structure shall continue to connections to the lightning protection ground electrode system. Down conductors shall be spaced at intervals averaging not more than 100 feet around the perimeter of the structure. In no case shall a structure have fewer than two down conductors. Down conductors shall be concealed from view. All conductors shall be concealed from view at street level.

H. In case of structural steel frame construction, down conductors may be omitted and roof conductors shall be connected to the structural steel frame at intervals not exceeding 100 feet along the perimeter of the structure.

2.5 ROOF PENETRATIONS

A. Roof penetrations required for down conductors or for connection to structural steel framework shall be made using thru-roof assemblies with solid riser bars or conduits and appropriate roof flashing. Conductors shall not pass directly through the roof. The roofing contractor shall furnish and install the materials required to properly seal all roof penetrations of the lightning protection components and any additional roofing materials or preparations required by the roofing manufacturer for lightning conductor runs to assure compatibility with the warranty for the roof including roof pads that may be required to protect the roof under each of the lightning protection components.

2.6 GROUND ELECTRODES

A. Each down conductor shall terminate at a ground electrode dedicated to the lightning protection system, or to a building or facility ground electrode system that consists of multiple ground electrodes that are interconnected with a ground ring conductor.

B. Ground rod electrodes shall be copper-clad steel, a minimum 5/8” diameter and 10 feet long. The down conductor shall be connected to the ground electrode using a bronze ground rod clamp having a minimum of 1½” contact between the ground rod electrode and the conductor measured parallel to the axis of the ground rod electrode, or by an Ultraweld exothermically welded connection. Ground rod electrodes shall be located a minimum of 2 feet below grade and shall be installed below the frost line where possible (excluding shallow topsoil conditions).

C. Where it is not possible to drive ground rod electrodes because of bedrock or shallow topsoil conditions, ground plate electrodes, radial electrodes, ground ring electrodes, concrete-encased electrodes, or combinations of these may be used in accordance with NFPA® 780.

D. Where the structural steel framework is utilized as down conductors for the system, ground electrodes shall be connected to columns around the perimeter of the structure at intervals averaging not more than 60 feet apart. Columns shall be grounded using either bonding plates having 8 square inches of surface contact area or by Ultraweld® exothermically welded connections.

2.7 COMMON BONDING OF GROUNDED SYSTEMS

A. Common bonding of all grounded systems within the building shall be ensured by interconnecting them to the lightning protection system using main size conductor and fittings.

B. For structures exceeding 60 feet in height, the interconnection of the lightning protection system ground electrodes and other grounded systems shall be in the form of a ground loop conductor.

C. These grounded systems shall include but are not limited to the electrical service, communication, and antenna system grounds as well as all underground metallic piping systems including water, gas, sewer, underground metallic conduits, etc. Interconnection to a gas line shall be made on the customer's side of the meter.

2.8 POTENTIAL EQUALIZATION

A. Grounded metal bodies located within the required bonding distance as determined by the bonding distance formula in NFPA® 780 shall be bonded to the lightning protection system using the required bonding conductors and connections.

PART 3. EXECUTION

3.1 INSTALLATION

A. The installation of the lightning protection system shall be done in a neat and workmanlike manner.

B. The lightning protection system shall be installed by or under the supervision of a UL listed lighting protection installer.

C. The installers shall have completed factory training and be so certified by the manufacturer.

D. Install the lightning protection system in accordance with the approved coordinated shop drawing and the referenced lightning protection system installation standards. Any deviations shall be brought to the immediate attention of the manufacturer so as not to delay certification.

E. Splices and clamps: Install cable with as few joints as possible. Use approved exothermic welded connections for all above grade connections, ungrounded conductor splices and all underground connections between conductors and ground rods. Use approved mechanical compression connections for above grade connections with specific Owner approval only.

F. Systems shall be semi-concealed, with all down-lead conductors and groundings concealed within the building, but with roof conductors and air terminals exposed on roof. Where possible, roof conductors and air terminals shall be installed on inside faces of parapets so that they are not visible from below.

G. Copper downlead conductors shall be used even when aluminum is required on the roof. Downlead cables in conduit shall not be brought directly through the roof. Thru roof assemblies with solid brass or stainless steel rods shall be utilized for this purpose.

H. PVC conduits may be used to conceal conductors, separate conductors from dissimilar metals, etc., in areas where there is no risk of physical damage. In areas where physical damage is probable; rigid metal conduit shall be used. The contractor shall ensure conduit materials meet above ceiling plenum ratings, where installed in that environment.

I. Ground Rods:

1. Install rods by driving and not by drilling or jetting.
2. Drive rods into unexcavated portions of the earth where possible.
3. Where rods must be installed in excavated areas, drive rods into earth after compaction of backfill is completed.
4. Drive to a depth such that the top of the rod will be approximately 18” below final grade or sub-grade.
5. Bond exterior metal bodies on building to the lightning protection system.

J. Corrosion Protection:

1. Use no combination of materials that may form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist that would cause deterioration or corrosion of conductors, use conductors with suitable protective coatings. Protect cable at all points where cable leaves concrete by wrapping rubber tape 2” on either side of the plane formed by the finished concrete surface.

3.2 COORDINATION

A. Coordinate the installation of the lightning protection system with other trades.

B. Coordinate all roof penetrations, fasteners and adhesive with the roofing contractor prior to installing any materials on the roof.

3.3 PROJECT DOCUMENTATION

A. Photo document all concealed portions of the lightning protection system as they are being installed. This includes lightning protection system grounding electrodes, connections to structural metal, connections to underground metal piping entering the structure, connections to

electrical and electronic service grounds, ground rings, etc. This documentation should be authenticated by the Owner or his representative.

B. Maintain accurate "as-built" drawings throughout the entire installation of the lightning protection system.

3.4 INSPECTION, CERTIFICATION AND MAINTENANCE

A. At completion of the installation of the lightning protection system, the contractor shall apply for inspection of the system by UL field representatives. The system is to be inspected for compliance with NFPA® 780. Owner's Representative shall receive at least at least 48-hour notification of an any inspection performed by the UL inspector.

B. If the lightning protection system covers an entire independent structure and the system passes inspection, UL will issue a Master Label® Certificate of Inspection for Lightning Protection System. The contractor will submit the certificate for distribution to the premises' Owner. For the certificate to be valid, the contractor must publish the certificate to the UL website, https://lps.ul.com where it may be viewed by consumers, building owners, insurance agencies and other interested parties. The Master Label® Certificate of Inspection is valid for a period of five years. If the building changes structurally or if modifications are made to the system during that period, the certificate is no longer valid.

C. At project closeout, the contractor shall provide the Owner with accurate as-built drawings as well as recommended guidelines for maintenance of the system.

END OF SECTION 26 41 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 51 00- LIGHTING

1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections apply to the work of this Section.

B. Division 26 "Basic Materials and Methods" sections apply to the work in this Section.

1.2 DESCRIPTION OF WORK

A. Types of interior and exterior lighting fixtures in this Section include the following:

1. LED

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacturer of interior and exterior light fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than three years.

B. Installer: Qualified with at least three years of successful installation experience on projects with interior and exterior lighting fixture work similar to that required for this project.

1.4 REFERENCES

A. NEC Compliance: Comply with the NEC as applicable to the installation and construction of lighting fixtures.

B. NEMA Compliance: Comply with applicable requirements of NEMA Standard Pub. Nos. LE-1 and LE-2 pertaining to lighting equipment.

C. ANSI/UL Compliance: Comply with ANSI/UL Standards pertaining to interior and exterior lighting fixtures for hazardous locations.

D. UL Compliance: Provide light fixtures that have been UL listed and labeled.

E. NECA Compliance: Comply with NECA's "Standard of Installation".

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data on lighting fixtures.

B. SHOP DRAWINGS

1. Furnish shop drawing portfolios (collated bound sets) containing the following information:

   a. Name of manufacturer
   b. Descriptive cut sheets
   c. Complete photometric information
   d. Coefficient of utilization tables
   e. Fixture voltage
   f. The number, type and wattage of the fixture lamps
   g. Lens types
   h. Fixture options
   i. Fixture mounting details
   j. Fixture door types
   k. Construction of fixture housing and/or door
   l. Fixture ballast manufacturer and type

2. All lighting fixtures required to be used on this project shall be submitted in one single submittal so that all fixtures can be reviewed at one time. Those fixtures not receiving a shop drawing action of "Reviewed" or "Reviewed and Noted" on the first submittal shall be resubmitted for review. A light fixture receiving a shop drawing action of "Resubmit" or "Rejected" after the third review for any reason, shall be furnished as originally specified.
3. The portfolios shall be made from standard manufacturer's specification sheets. Each fixture shall be identified by the letter or number indicated on the fixture schedule. The combining of more than one fixture type of fixture on a single sheet shall not be acceptable.

2. PRODUCTS

2.1 Manufacturer: Manufacturers of lighting fixtures are noted on the drawings by notes and/or by the light fixture schedule.

2.2 Substitutions: If the Contractor proposes to substitute lighting fixtures for those shown on the drawings or specified herein, he shall submit a list of proposed fixtures together with technical data to substantiate that the substitute fixtures are equivalent in all respects to the specified equipment. Proposed substitute fixtures must be submitted to the architect/engineer for review a minimum of ten (10) days prior to the project bid date. Only original documentation will be accepted for review. After review of the proposed substitute fixtures, an addendum or bid bulletin will be issued to include acceptable equipment. The review of substitute equipment in no way relieves the contractor of the responsibility to provide equipment that is equivalent in all respects to specified fixtures. Lighting fixtures as shown on the drawings or specified herein shall be used as a basis and standard of comparison in the review and consideration of fixtures

of other manufacturers. The Architect/Engineer shall have the final authority as to whether the fixture is equivalent to the specified item. The proposed substitution may be rejected for the aesthetic value if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item.

2.3 LED Drivers

A. Driver shall operate from 60 Hz input source of 120V through 277V with sustained variations of +/- 10 percent (voltage and frequency).

B. Driver input current shall have Total Harmonic Distortion (THD) of less than 20 percent when operated at nominal line voltage.

C. Driver shall have a Power Factor greater than 0.90.

D. Driver shall avoid interference with infrared devices and eliminate visible flicker.

E. Driver shall comply with ANSI C62.41 Category A for Transient protection.

F. Driver shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

G. The luminaire shall be capable of continuous dimming over a range of 100% to 5% of rated lumen output. Dimming shall be controlled by a 0-10VDC signal.

H. Control device must be compatible with type of driver, and coordinated prior to submission of shop drawings.

I. If driver is remote-mounted, provide maximum allowable distances for secondary wire runs to luminaires.

J. Provide with mounting hardware as required.

2.4 LED's

A. Color temperature specified shall be uniform for all LED modules within like luminaire types. Color temperature measurement shall have a maximum 2 SDCM on the MacAdam Ellipse.

B. Correlated color temperature as shown on plan. Minimum color rendering index (CRI) of 85.

C. LED light output and efficacy shall be measured in accordance with IES LM-79 standards.

D. LED life and lumen maintenance shall be measured in accordance with IES LM-80 standards.

E. Rated minimum life of 50,000 hours.

F. The individual LED's shall be connected such that a catastrophic loss or the failure of one LED will not result in a light output loss of the entire luminaire.

2.5 PLASTER FRAMES

A. Standard plaster frames shall be provided for all recessed lighting fixtures installed in plaster or drywall finished walls or ceilings. Coordinate with architectural drawings.

2.6 THERMAL PROTECTION

A. All recessed fixtures shall be provided with thermal protection per N.E.C requirements.

3. EXECUTION

3.1 INSTALLATION

A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of the NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. Coordinate with other electrical work as appropriate to properly interface installation of lighting fixtures with other work.

C. Adjust and Clean: Clean lighting fixtures of dirt and debris upon completion of the installation. Protect installed fixtures from damage during the remainder of the construction period.

D. Field Quality Control: Upon completion of the installation of lighting fixtures, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

E. Lighting fixture supports: Properly support and install fixtures in strict accordance with all applicable building codes and standards. Fully and completely coordinate the installation of fixtures with actual ceiling systems, and with all building trades. In general, provide fixture supports according to the following (unless applicable codes require more restrictive support details):

1. All lighting fixtures installed in grid type suspended ceiling systems, shall be positively attached to the ceiling system with clips that are UL listed for the application. In addition, a minimum of four (4) ceiling support system rods or wires shall be provided for each light fixture and shall be installed not more than six (6) inches from fixture corners. Provide

two (2) No. 12 gage hangers from each fixture housing to the building structure above (wires may be installed slack). Light fixtures that weigh more than 56 pounds shall be supported directly from the structure above by UL listed and approved hangers. Light fixtures that are smaller than the ceiling grid shall be installed at locations indicated on the reflected ceiling plans, or shall be installed in the center of the ceiling panel and shall be supported independently by at least two metal channels that span and are secured to the ceiling system.

2. Suspended lighting fixtures shall be supported directly from the building structure without using suspended ceilings as support systems. Support systems shall be UL listed and approved for the specific installation. Where pendants or rods exceed 48 inches in length, brace support systems to limit swinging.

F. Square and rectangular fixtures shall be mounted with sides parallel to building and ceiling lines, unless otherwise noted.

G. Where special fixtures to be used in special ceilings are scheduled, verify all ceiling system details and coordinate fixture type and accessories prior to ordering fixtures. Coordinate and cooperate with ceiling system supplier in the preparation of ceiling system shop drawings.

H. Install fixtures as recommended by the manufacturer, or as necessary to provide exact horizontal alignment, preventing horizontal or vertical deflection, or angular jointing of fixtures suspended in continuous rows.

END OF SECTION 26 51 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 00 00 - TELECOMMUNICATIONS

PART 1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this Section.

B. Division 26 "Basic Materials and Methods" sections apply to work specified in this Section.

PART 2. BUILDING WIRING SYSTEM DESIGN

2.1 GENERAL INFORMATION

A. Except for pathway construction, Division of IT will provide all material and equipment. This includes cable, voice/data/catv outlets and faceplates, equipment racks, and electronic equipment and all miscellaneous hardware.

B. The contractor will install owner-provided cable.

C. Cables do not need to be labeled by the contractor.

D. Division of IT will terminate, label and test all cabling and install all electronic equipment.

E. Cat6A shall be installed directionally from the telecom room outward.

PART 3. HORIZONTAL PATHWAYS AND SPACES

3.1 GENERAL INFORMATION

A. To avoid electromagnetic interference (EMI), all pathways shall provide clearances of at least 4 feet from motors or transformers, 1 foot from conduit and cables used for electrical power distribution, 5 inches from fluorescent lighting.

B. Horizontal Pathways:

1. Pathways must support cables and provide protection. Pathways should be planned to facilitate original installation as well as ongoing maintenance, additions, and relocations.
2. Conduit, trays, or other pathway hardware are to be used above the ceilings. Appropriate installation of horizontal pathways should prevent the hanging of cables loosely above

suspended ceilings. Contractor shall provide appropriate hardware (J-hooks, rings, etc.). Support hardware must not have sharp edges.

3. Cable trays should have twelve (12) inches of clearance above the tray. The contractor/installer should ensure that other building components (e.g., lighting fixtures, structural supports, air ducts) do not restrict access to the cable tray.
4. Cable routing, support, and sealing of penetrations must meet applicable UMC codes.
5. EZ Path series 44 fire wall sleeves are requires where a cable tray path crosses a firewall. The quantity of EZ Path series 44 fittings will equal the capacity of the cable tray, not just the initial cabling demands.
6. Conduit, cable tray, and J-hooks will be designed to allow a 40% growth.
7. Hanging cable supports must be no more than 5 feet apart as the installed cable must exhibit some sag in hanging. This provides visual evidence that cable tension is within 25 pounds as required in EIA-568-A.
8. Bundles of cables supported by typical J-hooks should not be larger than 50 cables, unless additional support is provided.
9. Horizontal pathway installation should take into consideration the horizontal cabling distance limitations of 90 meters (295 feet) from the telecommunications room to the outlet.
10. When conduit is used, sections of conduit shall be no longer than 150 ft and must not have more than or the equivalent of 270° bends between pull points or pull boxes.
11. Conduit inside bend radius must be:

Conduit size…	Bend radius…
2” or less	Six times the inside diameter
More than 2”	Ten times the inside diameter

12. Pull boxes should be placed directly after a bend or sized accordingly if the pull box is located at the bend.
13. Conduit fill limits must be followed to avoid over-packing cables:

Conduit Size…	# of cables…
1”	3 cables max
1-1/4”	4 cables max
1-1/2”	6 cables max
2”	12 cables max
3”	20 cables max

14. Dual channel raceway such as Wiremold 4000 a decora (GFCI) style device plate opening.
15. When possible, outlet locations should be placed above the work surfaces for easy access. Outlet boxes built into the floor are not recommended.
16. Cabling shall be supported above drop ceilings completely by cable tray or J-hooks.
17. Above hard lid, non-accessible ceilings, all cabling shall be installed in conduit.

PART 4. CABLING INSTALLATION AND DISTRIBUTION

4.1 CABLE TYPE, SOURCE OF MATERIALS, AND ASSIGNMENT OF TASKS

A. All vertical and horizontal in-building cable shall be plenum rated.

B. All cable will terminate in a telecom room on the same floor as the outlet.

C. Division of IT will install all backbone cable and perform terminating and testing of such facilities.

D. The contractor shall install owner provided cabling as specified for the project. The Division of IT will terminate and test all contractor installed cabling. Division of IT will provide all materials including cable, connecting hardware, terminals, equipment racks, etc.

E. The contractor/installer shall take into account the following critical installation practices when installing telecommunications cabling.

1. Physical separation from all sources of EMI is critical. Sources of EMI include but are not limited to: motors, transformers, copiers, construction equipment, and branch circuit power cables. Cabling that leaves physical pathways and extends into office areas must not lay on fluorescent lighting.
2. Conduit or other raceway pulling tensions should be minimized using suitable equipment and practices.
3. Cables must not lie on or be suspended from suspended ceiling support wires or frames.
4. Eliminate cable stress caused by tension in suspended cable runs. Cables must exhibit some sag in hanging between supports. Hanging supports, such as J-hooks, must be within 5 feet of each other.
5. Cables bundles should not be larger than 50 cables and shall not be tightly cinched together. Tie wraps must be hand tightened without tools. Cables must never be twisted.
6. Installations of CAT6A cable should have bend radii less than six (6) times the cable diameter. For fiber optic cable, the minimum recommended bend radius is ten (10) times the cable diameter, twenty (20) times the cable diameter if loaded.
7. Cables shall not be spliced under any circumstances. Damaged or broken cables must be completely replaced or decommissioned with a label attached at both ends.
8. Conduits should not be daisy chained together.
9. Provide adequate slack at both ends to accommodate terminations, unless otherwise noted on plans, provide:

Location…	**Slack length…**
Outlet	18 inches
Telecom Room	20 feet past termination point

END OF SECTION 27 00 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 28 31 11 – ADDRESSABLE FIRE ALARM SYSTEM

1. GENERAL

1.1 SUMMARY

A. AS A PART OF THIS PROJECT, THE EXISTING FIRE ALARM SYSTEM (Honeywell FCI) SHALL BE EXPANDED AS NECESSARY TO SERVE THE AREA OF RENOVATION. THE FOLLOWING SPECIFIES THE PERFORMANCE REQUIRMENTS FOR NEW DEVICES AND EQUIPMENT. ALL NEW COMPONENTS MUST BE FULLY AND COMPLETELY COMPATIBLE WITH THE EXISTING SYSTEM. IN ADDITION, THE CONTRACTOR SHALL PROVIDE ALL REQUIRED COMPONENTS TO EXPAND THE SYSTEM AS INDICATED.

B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.

1.2 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide alternate products by one of the following:

1. Honeywell FCI

B. The Manufacturer shall be a nationally recognized company specializing in fire alarm and detection systems. This organization shall employ factory trained and NICET certified technicians, and shall maintain a service organization within 100 miles of this project location. The Manufacturer and service organization shall have a minimum of 10 years experience in the fire protective signaling systems industry.

C. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.

1.3 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:

1. Division 26: "Basic Electrical Materials and Methods."
2. Division 26: "Wiring Methods."

C. The system and all associated operations shall be in accordance with the following:

1. Guidelines of the following Building Code: IBC
2. IFC
3. NFPA 72, National Fire Alarm Code
4. NFPA 70, National Electrical Code

5. NFPA 101, Life Safety Code
6. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
7. Other applicable NFPA standards
8. Local Jurisdictional Adopted Codes and Standards
9. ADA Accessibility Guidelines

1.4 SYSTEM DESCRIPTION

A. General: Provide a complete, non-coded, addressable, microprocessor-based, **horn-based** fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.

B. Wiring/Signal Transmission:

1. Transmission shall be hard-wired, using separate individual circuits for addressable signal transmission, dedicated to fire alarm service only].
2. System connections for initiating SLC circuits and notification appliance circuits.
3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.

C. Analog Smoke Sensors:

1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a video display or printed for annual recording and logging of the calibration maintenance schedule.
5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to indicate that a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate that a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a dirty sensor without creating a trouble in the system. If this indicator is ignored, a second level "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported to the Central Monitoring Station. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.

6. The FACP shall continuously perform an automatic self-test on each sensor which will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
7. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.
8. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.

D. Smoke Detectors: A maintenance and testing service providing the following shall be included with the base bid:

1. Biannual sensitivity reading and logging for each smoke sensor.
2. Scheduled biannual threshold adjustments to maintain proper sensitivity for each smoke sensor.
3. Threshold adjustment to any smoke sensor that has alarmed the system without the presence of particles of combustion.
4. Scheduled biannual cleaning or replacement of each smoke detector or sensor within the system.
5. Semi-annual functional testing of each smoke detector or sensor using the manufacturer's calibrated test tool.
6. Written documentation of all testing, cleaning, replacing, threshold adjustment, and sensitivity reading for each smoke detector or sensor device within the system.
7. The initial service included in the bid price shall provide the above listed procedures for a period of five years after owner acceptance of the system.

E. Audible Alarm Notification: By tone signals on horns in areas as indicated on drawings.

F. Visual Alarm Notification: By xenon flash tube signal on fire alarm strobe devices in areas as indicated on drawings.

G. Fire Suppression Monitoring:

1. Water flow: Activation of a water flow switch shall initiate general alarm operations.
2. Sprinkler/Stand Pipe valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
3. WSO: Water flow switch and sprinkler/stand pipe valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device is in alarm on the initiating zone.

H. Power Requirements

1. The control unit shall receive AC power via a dedicated branch circuit.
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in accordance with code requirements. All battery charging and recharging operations shall be automatic.
3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.

4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously while incoming power is present.
5. The system batteries shall be supervised so that a low battery or depleted battery condition or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control
7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
8. All notification circuits shall have a minimum of 20% spare current draw capacity for future devices. At a minimum, each floor shall be on its own circuit. Provide additional circuits per floor as required to accommodate actual number of devices shown on plan.
9. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

1.5 SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.

1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
2. Wiring diagrams from manufacturer.
3. Shop drawings showing system details including location of FACP, all devices, circuiting and details of annunciator. All notification circuits shall have a minimum of 20% spare current draw capacity for future devices.
4. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, NAC, relay, sensor, and auxiliary control circuits.
6. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
7. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
8. Record of field tests of system.

B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of

shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A factory authorized installer is to perform the work of this section.

B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

2. PRODUCTS

2.1 EMERGENCY POWER SUPPLY

A. General: Components include battery, charger, and an automatic transfer switch.

B. Battery: Sealed lead-acid. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of time in accordance with code requirements and as follows:

1. Batteries must be capable of operating the system in normal mode for 24 hours with sufficient capacity to operate the panel in alarm mode for 15 minutes at the end of that 24 hour period.

C. Battery size shall be a minimum of 125% of the calculated size.

2.2 ADDRESSABLE MANUAL PULL STATIONS

A. Description: Addressable single-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.

B. Protective Shield: Provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

2.3 ADDRESSABLE SMOKE SENSORS

A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:

1. Factory Nameplate: Serial number and type identification.
2. Operating Voltage: 24 VDC, nominal.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.

4. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
5. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit. In alarm condition, the sensor base LED shall be on steady.
6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
7. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
8. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
9. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP.

B. Type: Smoke sensors shall be of the photoelectric or combination photoelectric / heat type. Where acceptable per manufacturer specifications, ionization type sensors may be used.

C. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.

D. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. In ducts with air-duct velocities lower than 100 feet per minute (transfer ducts, large air plenums, etc.) the detector shall have an air-duct velocity range of 0-3000 feet per minute. Coordinate all air velocity ranges with the Division 23 Contractor. Sensor includes relay as required for fan shutdown.

1. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
3. Duct Housing shall provide a relay control trouble indicator Yellow LED.
4. Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
5. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
6. Housing shall provide a magnetic test area and Red sensor status LED.
7. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
8. Each duct sensor shall have a Remote Test Station with an alarm LED and test switch.

9. Where indicated a NEMA 4X weatherproof duct housing enclosure shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.
10. Detector shall have dry contacts for connection to BMS system.

2.4 ADDRESSABLE HEAT SENSORS

A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.

B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.

C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and] programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.

D. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

2.5 ADDRESSABLE CIRCUIT INTERFACE MODULES

A. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of evacuation indicating appliances and AHU systems.

B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required. The two-wire signaling line circuit shall supply power and communications to the module.

C. There shall be the following types of modules:

1. Type 1: Monitor Circuit Interface Module:

   a. For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.
   b. For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.

2. Type 2: Monitor Circuit Interface Module

a. This type of module is an individually addressable module that has both its power and its communications supplied by the two wire multiplexing signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.
b. This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short).

3. Type 3: Single Address Multi-Point Interface Modules

a. This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.
b. This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.
c. This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.

4. Type 4: Control Circuit Interface Module

a. This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.

5. Type 5: 4-20 mA Analog Monitor Circuit Interface Module

a. This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.

D. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a

troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.6 MAGNETIC DOOR HOLDERS

A. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develops a minimum of 25 lbs. holding force.

B. Material and Finish: Match door hardware.

2.7 ALARM NOTIFICATION APPLIANCES **(match existing color)**

A. Notification Appliances: The Contractor shall furnish and install Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).

1. Notification appliance operation shall provide power, supervision and separate control of horns and strobes over a single pair of wires. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.
2. Class B (Style 4) notification appliances shall be wired without requiring traditional in/out wiring methods; addressable "T" Tapping shall be permitted. Up to 63 appliances can be supported on a single channel.
3. Each notification appliance shall contain an electronic module. This on-board module shall allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications.

B. Audible: Horn shall be listed to UL 464. Horn appliances shall have a High/Lo Setting, programmable by channel from the controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot.

C. Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

D. Audible/Visible: Combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating

of the specific strobe. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The appliance shall be capable of two-wire synchronization with one of the following options:

1. Synchronized Strobe with Horn on steady
2. Synchronized Strobe with Temporal Code Pattern on Horn
3. Synchronized Strobe with March Time cadence on Horn
4. Synchronized Strobe firing to NAC sync signal with Horn silenced

E. Isolator Module: Isolator module provides short circuit isolation for notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:

1. Report faults to the host FACP.
2. On-board Yellow LED provides module status.
3. After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.

F. Accessories: The contractor shall furnish the necessary accessories.

2.8 NAC Power Extender

A. The Controller shall be a stand-alone panel capable of powering a minimum of 3 Signaling line circuits. Each channel shall be rated for 2.5 amps and support up to 63 notification appliances. Power and communication for the notification appliances shall be provided on the same pair of wires.

B. SLC notification appliance circuits shall be Class B Style 4.

C. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.

D. The NAC extender panel may be mounted close to the host control panel or can be remotely located.

3. EXECUTION

3.1 INSTALLATION, GENERAL

A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:

1. Factory trained and certified personnel.
2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
3. Personnel licensed or certified by state or local authority.

3.2 EQUIPMENT INSTALLATION

A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.

B. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler/stand pipe valve required to be supervised.

C. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

3.3 WIRING INSTALLATION

A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AHJ) and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).

B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.

C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

D. Install all fire alarm system wiring in red conduit.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:

1. Factory trained and certified.
2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
3. International Municipal Signal Association (IMSA) fire alarm certified.
4. Certified by a state or local authority.
5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.

D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.

H. Final Test, Certificate of Completion, and Certificate of Occupancy:

1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.

3.5 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.

B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

END OF SECTION 28 31 11

SECTION 28 55 00 – RF SURVEY FOR IN-BUILDING TWO-WAY EMERGENCY RESPONDER COMMUNICATION ENHANCEMENT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

1. The purpose of this specification is to establish the requirements and standards for initial survey for public safety radio signal strength per NFPA and IFC

2. Survey should be performed after the building is substantially completed, and prior to start of installation of electrical wiring.

3. Conduct a survey using a RF Spectrum Analyzer, a calibrated, system-compatible radio or another suitable instrument with traceable certificate of calibration to analyze the RF signal strength of Emergency Responder Radio Signal into the building and determine if amplification of the signal is required. Both inbound and outbound signal strength shall be determined, measured, calculated and documented as required by code.

1.2 SURVEY CRITERIA IF REQUIRED

1. The required Public Safety Radio Signal Level inside the Owner's facility must be determined per code, ordinance or AHJ

2. The minimum qualifications of the system designer and lead installation personnel shall include both of the following:

    1. A valid FCC-issued general radio operators license.
    2. Certification of in-building system training issued by a nationally recognized organization, school or a certificate issued by the manufacturer of the equipment being installed.

1.3 REGULATIONS

1. Codes, regulations and standards referenced in the Section are:

    1. NFPA 1 – The National Fire Code (including Annex O from 2009)
    2. NFPA 70 – The National Electrical Code
    3. IFC 510- Emergency Responder Radio Coverage
    4. NFPA 101, Life Safety Code, the Ohio Building Code, and Local Code and Building Authority requirements.
    5. NFPA 72 National Fire Alarm Code
    6. FCC 47 CFR Private Land Mobile Radio
    7. 90.219 Services-Use of Signal Boosters

8. ICC International Fire Code, Code and Commentary
9. Local or State Promulgated Fire Code
10. ADA "Americans with Disabilities Act"
11. FCC's OET 65 Standards "Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields"
12. FCC Rules Part 22, Part 90 and Part 101
13. NFPA 1221 2016 Edition or later
14. International Building Code 2012 / 2015 / 2018 or later
15. UL 2524 2nd Edition

1.4 DEFINITIONS

1. Definitions:

1. Bi-Directional Amplifier BDA / Fiber DAS Master/Remote: Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station and in the downlink from the base station to subscriber devices for enhanced signals and improved coverage.
2. In-building Two-way Emergency Responder Communication Enhancement System: A two-way radio communication system installed to assure the effective operation of radio communications systems for fire, emergency medical services, or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.
3. FCC: Federal Communications Commission
4. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
5. Public Safety/First Responder: Public Safety or First Responder agencies that are charged with the responsibility of responding to emergency situations. These include, but are not limited to law enforcement departments, fire departments, and emergency medical companies.
6. RSSI: Received signal strength indicator RSSI is a measurement of the power present in a received radio signal.
7. BER: Bit Error Rate is the number of bit errors per unit time
8. GROL- FCC General Radio Operators License
9. ERCES- Emergency Responder Communication Enhancement System
10. DAS-Distributed Antenna System

PART 2. EXECUTION

2.1 TESTING PROCEDURES

1. Minimum Signal Strength: For testing system signal strength and quality, the testing shall be based on the. -95dBm nominal signal at 100%.
2. Spectrum Analyzer or Calibrated Handheld Radio or Scanning Receiver shall be used as basis for signal measurements or other method as approved by AHJ.
3. Testing should be based on a minimum of 20 grid locations per floor OR maximum of 1600 SQ ft. areas if the floor exceeds 32,000 Sq. Ft. Also, testing should include all critical areas

per NFPA. See 1.02 of this specification and NFPA 72 2013 or NFPA 1221 2016. OR per any method determined by the AHJ, local code or ordinance.

4. A minimum signal strength of -95 dBm shall be provided throughout the coverage area for both uplink and downlink by the Local Fire Department.

    a. RSSI measurement only

2.2 SURVEY SUBMITTALS

1. Submit testing data for each level of the building.

    1. An RF measurement drawing of each floor of the building which indicates relative RF field strength for each frequency band of interest must be submitted to the AHJ.
    2. The drawing should indicate clearly the areas that have passed or failed based on the above parameters.

END OF SECTION 28 55 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 311000
SITE CLEARING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.02 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.03 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

B. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
1. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. The following practices are prohibited within protection zones:
1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 PRODUCTS

2.01 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.03 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Design Professional.

3.04 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
   1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Design Professional not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Design Professional's written permission.

3.05 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
   2. Use only hand methods for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.06 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches (150 mm) in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.07 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.08 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 312000
EARTH MOVING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Excavation for paving and grading.
2. Excavation for building foundations, slabs-on-grade, paving, and grading.
3. Excavation for Site structures.
4. Site filing and backfilling.
5. Drainage course for slabs-on-grade.
6. Consolidation and compaction.
7. Excavation for trenches for utilities and footings.
8. Consolidation and compaction of bedding under utilities.
9. Rough grading.

B. Related Sections:
1. Section 015713 – Temporary Erosion and Sediment Control.
2. Section 311000 – Site Clearing.
3. Section 331100 - Water Utility Distribution Piping
4. Section 333100 – Sanitary Utility Sewerage Piping
5. Section 334100 – Storm Utility Drainage Piping.
6. Section 334613 – Foundation Drainage.

1.02 DEFINITIONS

A. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials, and bottom of over excavation areas if required by the contract document.

B. Subbase Course: Aggregate layer placed between the subgrade and hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill, when sufficient approved soil material is not available from excavations.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated, regardless of the character and density of materials, including reuse or disposal of materials removed.
1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Design Professional. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Design Professional. Unauthorized excavation, as well as remedial work directed by Design Professional, shall be without additional compensation.

G. Fill: Suitable materials used to raise existing grades.

H. Finish Grade: The top surface of sod, top surface of topsoil where sod is not indicated or exposed rock surface where indicated on the drawing.

I. Trench Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

L. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed **1 cu. yd. (0.76 cu. m)** for bulk excavation or **3/4 cu. yd. (0.57 cu. m)** for footing and trench excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
   1. Equipment for Footing and Trench: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,700 lbf (128 kN) and stick-crowd force of not less than 18,400 lbf (82 kN) with extra-long reach boom.
   2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp (172-kW) flywheel power and developing a minimum of 47,992-lbf (213.3-kN) breakout force with a general-purpose bare bucket.

1.03 SUBMITTALS

A. Submit in accordance with Division 1 unless otherwise indicated.

B. Product Data: For each type of material indicated in Part 2 of this section.

C. Contract Closeout Submittals: Submit in accordance with Division 1.
   1. Project Record Documents.
      a. Accurately record location of underground utilities remaining, rerouted utilities, and new utilities by horizontal dimensions from above grade permanent fixtures, elevations or inverts, and slope gradients.

D. Soil testing reports as required by Section 1.04B

1.04 QUALITY ASSURANCE

A. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following:
   1. Not less than 3 years experience with systems.
   2. Successfully completed not less than 5 comparable scale projects using this system.

B. Testing Agency: A qualified independent geotechnical engineering testing agency shall classify proposed on-Site and borrow soils to verify that soils comply with specified requirements and to perform specified field and laboratory testing.

C. Pre-excavation Conference:

1. Convene pre-excavation conference under provision of Division 1, one week prior to commencing Work of this Section.
2. Contractor shall be presiding officer at conference.
3. Conference shall be attended by Contractor, Owner's Representative, testing agency, and earthwork subcontractor.
4. Purpose of conference will be to review contract requirements and discuss schedules, work procedures, acceptable materials specified under this Section, locations where specified materials may be incorporated, and quality control.

1.05 PROJECT CONDITIONS

A. Existing Conditions:
1. Locate existing underground utilities in areas of excavation Work.
   a. Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted in writing by Owner's Representative and then only after acceptable temporary utility services have been provided.
   b. Provide not less than 72 hours notice to Design Professional and Owner's Representative and receive written authorization to proceed before interrupting any utility.

1.06 MAINTENANCE

A. Where settling is measurable or observable at excavated areas during correction period required by General Conditions, remove surface (pavement, lawn, or other finish), add backfill material, compact as specified in this Section for location of material, and replace surface treatment.
1. Restore appearance, quality, and condition of surface or finish to match adjacent materials.
2. Eliminate evidence of restoration.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
1. Provide approved borrow soil materials from off-Site when sufficient approved soil materials are not available from excavations, at no increase in Contract Sum or extension of Contract Time.
2. Dispose of any excess materials legally off site at no increase in contract sum or extension of contract time. On site disposal of suitable materials may only be permitted where shown on the drawings.
3. Fill and backfill materials shall be subject to the approval of testing agency and the Owner's Representative.
4. For approval of fill and backfill materials, notify testing agency and Owner's Representative at least 5 working days in advance of intention to import material.
   a. Designate proposed borrow area and excavate test pits to permit testing agency to sample as necessary from borrow area for the purpose of making acceptance tests to confirm quality of proposed material.

B. General Fill Materials
1. Definition: That material used to obtain finish subgrade levels at locations specified under this section.
2. Acceptable material: Excavated on-Site material or off-Site borrow material which is free from debris, organics, decomposable, and corrodible materials, and containing the proper

moisture content, liquid limit, and plasticity index to obtain specified compaction requirements.

a. Existing on-Site material proposed for reuse, and off-Site borrow material shall be approved by testing agency.

C. Structural Fill and Backfill

1. Engineered fill is defined as crushed limestone aggregate containing sufficient fines to establish moisture/density relationship. Engineered fill shall be free of frozen soil, organics, rubbish, large rocks, wood, or other deleterious material. Cohesive soils shall be uniformly compacted to at least 95 percent of the maximum standard dry density and be within -2 to +3 percent of optimum moisture content as described by ASTM D698. Engineered fill, such as MoDOT Type 5 Aggregate, shall be compacted to at least 95% of the maximum dry density as determined by the Standard Proctor, ASTM D698. The moisture content shall be high enough to provide for proper compaction but low enough to prevent undue pumping. Should the results of the in-place density tests indicate that the specified compaction limits have not been achieved, the area represented by the test shall be reworked and retested as required until the specified limits are reached. Proposed fill shall be analyzed by the geotechnical engineer prior to use.
2. The fill material shall be placed in layers, not to exceed eight inches in loose thickness, and shall be wetted or dried as required to secure specified compaction. Effective spreading equipment shall be used on each lift to obtain a uniform lift thickness prior to compaction. Each layer shall be uniformly compacted by means of suitable equipment of the type required by the materials composing the fill. The fill layers shall be placed approximately parallel to the finished grade.

D. Low Volume Change Material:

1. Definition: That material used to obtain the upper 24 inches of finish subgrade beneath granular base in building areas, and material used as trench backfill material in building areas.
2. Acceptable material:
   a. On-site or Off-Site borrow material which is free from debris, organics, decomposable, and corrodible materials with a liquid limit of less than 40 percent, or another material acceptable to the testing agency.
      1) Existing on-Site material proposed for reuse, and off-Site borrow material shall be approved by testing agency.
   b. MoDOT Type 5 Aggregate

E. Granular Fill:

1. Definition: Free-draining granular base used beneath building slabs-on-grade and used as backfill behind foundation and retaining walls.
2. Acceptable materials: MoDOT Type 1 Aggregate.

F. Pavement Subbase Course:

1. Definition: Granular base used beneath concrete pavement and other pavements indicated on Drawings.
2. Acceptable materials: MoDOT Type 5 Aggregate.

G. Bedding Materials: Type 1 aggregate per MoDOT Standard Specification for Highway Construction, Section 1007.

H. Trench Backfill Materials:

1. Slab on grades: Low volume change materials per this section.
2. Pavement areas: Low volume change material per this section.

3. Other areas: General Fill Material or other materials specified under this Section at locations specified or indicated on Drawings.

I. Backfill Material
1. Definition: Material requiring placement and compaction with manual procedures because of restricted spaces or new construction.
2. Acceptable materials: Either General Fill Material, Granular Fill Material, or other materials specified under this Section at locations specified or indicated on Drawings.

J. Unsuitable Material
1. Definition: That excavated material which does not meet the consistency requirements of any other defined materials in this Section, including muck, frozen material, organic material, top soil, rubbish, and rock within the limits defined for General Fill Material
2. Dispose of unsuitable material off-Site, at no increase in Contract Sum or extension of Contract Time.
a. Submit an acceptable agreement with the property owner on whose property the unsuitable material is placed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
1. Verify location and elevations of existing building foundations.
2. Verify location and elevations of existing underground utilities.
3. Verify erosion control systems are in place.
4. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection:
1. Protect trees, shrubs, lawns, other plant growth, and other features indicated on Drawings to remain.
2. Protect bench marks, monuments, existing structures, existing fences, existing roads, existing sidewalks, existing paving, and existing curbs from damage caused by settlement, lateral movement, undermining, washout, and other hazards caused by Work of this Section.
a. If damaged or displaced, notify Owner's Representative and correct defects as directed by Owner's Representative.
3. Protect above and below grade utilities which are to remain.
4. Protect adjacent and downstream properties from pollution, sedimentation, or erosion caused by the work of this Contract.

B. Precautions:
1. Use all means necessary to control dust on and near the Work, and on and near off-Site borrow storage, and spoil areas, if such dust is caused by performance of the Work of this Section, or if resulting from the condition in which Project Site is left by Contractor.
2. Moisten surfaces as required to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other Work on Project Site.
3. Identify required lines, levels, contours, and datum.
4. Identify above and below grade utilities.
5. Provide and maintain positive surface drainage.

3.03 WATER CONTROL

A. Provide berms or channels to prevent flooding of subgrades.

B. Prevent infiltration of water into excavations from whatever sources as may exist.

C. Prevent ponding of water on finish subgrades.

D. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

E. Prevent flooding of Project Site and surrounding areas.

F. Promptly remove water collection in depressions.
   1. Provide and maintain ample means and devices with which to remove and dispose of water entering excavations.
   2. Ensure dry excavations and preservation of final lines and grades of bottoms of excavations.

3.04 EXCAVATION, GENERAL

A. Excavation above subgrade as defined in paragraph 1.2 of this section is unclassified and includes excavation of any material encountered regardless of its character including rock, soil materials, debris, and other obstructions and shall be included in the base bid.

B. Perform excavation to the lines and grades indicated on Drawings within a tolerance of 0.10 foot.
   1. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, installing services and other construction, and for inspections.

C. Perform Excavation Work in compliance with applicable requirements of authorities having jurisdiction, including United States Department of Labor, Occupational Safety and Health Administration (OSHA) “Construction Standards for Excavations, 29 CFR Part 1926”.

D. Perform Work in a manner and sequence that will provide drainage at all times and that will prevent surface water from draining into excavations.

E. Protect subgrades and foundation soils against freezing temperatures and frost.
   1. Provide protective insulation materials as necessary.

F. When excavating through roots, perform Work by hand cutting roots with sharp axe.

G. Excavation cut shall not interfere with normal 45 degree bearing splay of foundations.

H. Machine slope banks to comply with local codes, ordinances, and requirements of agencies having jurisdiction.
   1. Provide materials for shoring and bracing.
      a. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
      b. Extend shoring and bracing as excavation progresses
   2. Control surface drainage down slopes.
   3. Cover slopes to prevent loss of moisture content of soil and to prevent raveling.

I. When materials encountered at subgrade are determined to be unacceptable for use by testing agency, remove such material to depths and limits determined by testing agency.
   1. Backfill with material acceptable to testing agency and compact to density equal to the specified requirements for subsequent fill material.

J. Where depressions result from, or have resulted from the removal of surface or subsurface obstructions, open depressions to equipment working width, and remove debris and soft

material as directed by testing agency, at no increase in Contract Sum or extension of Contract time.

1. Backfill with material acceptable to testing agency and compact to density equal to the specified requirements for subsequent fill material, at no increase in Contract Sum or extension of Contract Time.

K. Backfill and compact over-excavations and unauthorized as specified for the area at which it occurs, at no increase in Contract Sum or extension of Contract Time.

1. Backfill with material acceptable to testing agency and compact to density equal to the specified requirements for subsequent fill material, at no increase in Contract Sum or extension of Contract Time.

L. Stockpile excavation material which testing agency has approved for reuse.

1. Stockpile soil materials without intermixing soil materials with different consistencies and gradation.
2. Place, grade, and shape stockpiles to drain surface water.
3. Do not stockpile within drip line of trees which are to remain.
4. Cover stockpiles to prevent wind-blown dust.

M. Remove unacceptable excavation material from Site, at no increase in Contract Sum or extension of Contract Time.

N. Hand trim excavations.

1. Remove loose matter.

O. Excavation for Footings and Foundations:

1. Do not disturb bottom of excavation.
   a. Excavate by hand to final grade immediately prior to placement of concrete reinforcement.
   b. Trim bottom of excavations to required lines and grades to leave solid base to receive other work.
2. Drill probe holes at exposed bottom of excavations as directed by testing agency.

3.05 TRENCH EXCAVATIONS

A. Trench excavation is unclassified and includes excavation to required exposed subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, debris, and other obstructions.

B. Excavate trenches to gradients, lines, depths, and elevations indicated on Drawings, within a tolerance of 0.10 foot.

C. Perform excavation Work in compliance with applicable requirements of authorities having jurisdiction, including United States Department of Labor, Occupational Safety and Health Administration (OSHA) "Construction Standards for Excavations, 29 CFR Part 1926".

D. Do not perform trench excavation in areas to receive fill until fill operations are complete to an elevation of not less than 24 inches above the top of the proposed pipe or conduit for which the trench is to receive.

E. Perform Work in a manner and sequence that will provide drainage at all times and that will prevent surface water from draining into trenches.

F. Protect subgrades against freezing temperatures and frost.

G. Provide protective insulation materials as necessary.

H. When excavating through roots, perform Work by hand cutting roots with a sharp axe.

I. Excavation cut shall not interfere with normal 45 degree bearing splay of foundations.

J. Excavate trenches to uniform width, sufficiently wide to enable installation of utilities and to allow safe inspection of installed utilities.

K. Excavate trenches 6 inches deeper than bottom of pipe elevation to allow for bedding course
   1. Hand excavate for bell of pipe.
   2. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
   3. Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
   4. Provide materials for shoring and bracing.
      a. Maintain shoring and bracing in trenches regardless of time period trenches will be open.
      b. Extend shoring and bracing as excavation progresses.
   5. Control surface drainage down slopes.
   6. Cover slopes to prevent loss of moisture content of soil and to prevent raveling.
   7. Hand trim trenches.
      a. Remove loose matter.

L. When subgrade materials are encountered which testing agency determines to be unacceptable for use, remove such material to depths and limits determined by testing agency:
   1. Backfill with material acceptable to testing agency and compact to density equal to the specified requirements for subsequent fill material.
   2. Removal and replacement of unacceptable material will be paid on basis of Unit Prices included in the Contract Documents.

M. Where depressions result from, or have resulted from the removal of surface or subsurface obstructions, open depressions to equipment working width, and remove debris and soft material as directed by testing agency at no increase in Contract Sum or extension of Contract Time.
   1. Backfill with material acceptable to testing agency and compact to density equal to the specified requirements for subsequent fill material, at no increase in Contract Sum or extension of Contract Time.

N. Stockpile excavation material which testing agency has approved for reuse.
   1. Stockpile soil materials without intermixing soil materials with different consistencies and gradations.
   2. Place, grade, and shape stockpiles to drain surface water.
   3. Do not stockpile within drip line of trees which are to remain.
   4. Cover stockpiles to prevent wind-blown dust.

O. Remove unacceptable excavation material from Site, at no increase in Contract Sum or extension of Contract Time.
   1. Submit an acceptable agreement with the property owner on whose property the unsuitable material is placed.

3.06 SUBGRADE PREPARATION FOR BUILDING SLABS-ON-GRADE

A. General:
   1. Excavation for subgrade preparation is unclassified and includes excavation to required subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, debris, and other obstructions.
   2. Testing agency shall be present to observe and evaluate subgrades in building areas prior to placement of fill and/or low volume change materials and shall be present during

placement and compaction of fill materials in building areas. Undercut as specified herein to develop 24 inch thick low volume change zone below building floor slabs. Subgrades in building areas shall be observed and evaluated by geotechnical engineer prior to fill and/or low volume change placement. Evaluation may include probing by geotechnical engineer and opening of test pits and/or test trenches with contractors assistance to explore areas of suspected unsuitable materials. Subgrades shall also be proof-rolled with loaded tandem axle dump truck in presence of geotechnical engineer and scarified, moisture conditioned and recompacted as specified herein prior to placement of fill and/or low volume change materials.

3. Fill material shall not be placed, spread, or rolled while the material is frozen or thawing, or during unfavorable weather conditions.
4. Moisture condition or dry fill material as required to obtain specified moisture content limits.
    a. Material which is too wet to allow proper compaction, as determined by testing agency, may be spread and permitted to dry assisted by disking, harrowing, or pulverizing.
5. Place fill material using spreading equipment capable of obtaining uniform loose lift thickness.
6. Compact fill material using equipment appropriate to the material being compacted, as determined by testing agency.
7. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed fill area is as specified.
8. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
9. In excavations where testing agency determines that subgrade material is unacceptable, remove unacceptable material and backfill in accordance with procedures determined by testing agency.
10. Minimize construction traffic, including foot traffic, from floor slab finished subgrades in order to prevent unnecessary disturbances of subgrade materials.
    a. If testing agency determines that finished subgrades have been disturbed, remove disturbed areas and replace and recompact to required density as directed by testing agency.
    b. If testing agency determines that rutting has occurred, excavate 6 inches, or other depth as directed by testing agency, of subgrade material and recompact as specified for affected area.
    c. Testing agency shall be present during compaction of material.

B. In cut areas below building slabs-on-grade requiring less than 24 inches of fill to obtain finish subgrade elevations, and a lateral distance of 5 feet outside building areas, excavate existing materials to a depth of not less than 24 inches below bottom of floor slab granular fill.
1. Scarify subgrade to a depth of 6 inches to result in a surface free from ruts, hummocks, and other uneven features which, in the opinion of the testing agency, would prevent uniform compaction by the equipment proposed for use.
    a. Moisture condition subgrade to achieve moisture content specified in this Section.
    b. Compact to a minimum of 95% of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698.
        1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.

2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

2. After scarifying, moisture conditioning, and recompacting, backfill fill areas using low volume change materials placed in loose lifts not exceeding 8 inches.
   a. Compact each lift of low volume change clay soil to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698. Compact each lift of granular low volume change material to a minimum of 95 percent of the material's maximum standard proctor dry density at a workable moisture content sufficient to obtain the required density.
      1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
      2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
3. Fill operations shall continue in compacted layers until finish subgrade elevations have been obtained.
   a. Compact each lift of low volume change clay soil to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698. Compact each lift of granular low volume change material to a minimum of 95 percent of the material's maximum standard proctor dry density at a workable moisture content sufficient to obtain the required density.
      1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
      2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
4. Protect excavations from excessive wetting and drying during construction.
   a. Remove water entering excavation, and remove disturbed or softened soil.
5. The upper 24 inches of fill material shall be low volume change material.
6. Maintain subgrade moisture content within specified range until building slabs-on-grade are installed.
   a. Rework non-complying area as required to achieve specified requirements as directed by testing agency.
   b. Recompact and retest until required density and moisture content is obtained.

C. In areas below building slabs-on-grade requiring 24 inches or more of fill to obtain finish subgrade elevations, and a lateral distance of 5 feet outside building areas, scarify subgrade to a depth of 6 inches to result in surface free from ruts, hummocks, and other uneven features which, in the opinion testing agency, would prevent uniform compaction by the equipment proposed for use.
   1. Moisture condition subgrade to achieve moisture content specified in this Section.
      a. Compact to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698.
         1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.

2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

2. After scarifying, moisture conditioning, and recompacting, backfill areas using suitable materials as specified herein placed in loose lifts not exceeding 8 inches. Suitable on-site clay materials may be used below the 24-inch thick low volume change zone.
   a. Compact each lift of suitable clay soil or low volume change material to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698. Compact each lift of granular low volume change material to a minimum of 95 percent of the material's maximum Standard Proctor dry density at workable moisture content sufficient to obtain the required density.
      1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
      2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
3. Fill operations shall continue in compacted layers until finish subgrade elevations have been obtained.
   a. Compact each lift of suitable clay soil or low volume change material to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698.
      1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
      2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
4. Protect excavations from excessive wetting and drying during construction.
   a. Remove water entering excavation, and remove disturbed or softened soil.
5. The upper 24 inches of fill material shall be low volume change material.
6. Maintain subgrade moisture content within specified range until building slabs-on-grade are installed.
   a. Rework non-complying area as required to achieve specified requirements as directed by testing agency.
   b. Recompact and retest until required density and moisture content is obtained.

D. Tolerances:
   1. Top surface of finish subgrade under slabs-on-grade: Plus or minus ¼ inch from required elevations.

3.07 SUBGRADE PREPARATION FOR FOUNDATION FOOTING

A. General:
   1. Excavation for subgrade preparation for foundations is unclassified and includes excavation to required subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, debris, and other obstructions.
   2. Testing agency shall be present during placement and compaction of fill material.
   3. Fill material shall not be placed, spread, or rolled while the material is frozen or thawing, or during unfavorable weather conditions.

4. Moisture condition dry fill material as required to obtain specified moisture content limits.
   a. Material which is too wet to allow proper compaction, as determined by testing agency, may be spread and permitted to dry assisted by disking, harrowing, or pulverizing.
5. Place fill material using spreading equipment capable of obtaining uniform loose lift thickness.
6. Compact fill material using equipment appropriate to the material being compacted, as determined by testing agency.
7. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed fill area is as specified.
8. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
9. In excavations where testing agency determines that subgrade material is unacceptable, remove unacceptable material and backfill in accordance with procedures determined by testing agency.
10. Minimize construction traffic, including foot traffic, from floor slab finished subgrades in order to prevent unnecessary disturbances of subgrade materials.
    a. If testing agency determines that finished subgrades have been disturbed, remove disturbed areas and replace and recompact to required density as directed by testing agency.
    b. If testing agency determines that rutting has occurred, excavate 6 inches, or other depth as directed by testing agency, of subgrade material and recompact as specified for affected area.
    c. Testing agency shall be present during compaction of material.

3.08 SUBGRADE PREPARATION AT PAVEMENTS

A. General:
1. Excavation for subgrade preparation is unclassified and includes excavation to required subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, debris, and other obstructions.
2. Testing agency shall be present to observe proof-rolling of subgrades in pavement and sidewalk areas prior to placement of fill and shall be present during placement and compaction of fill materials in pavement and sidewalk areas. Testing agency shall also be present to observe proof-rolling of finished subgrades prior to installation of pavement and sidewalk sections.
3. Fill material shall not be placed, spread, or rolled while the material is frozen or thawing, or during unfavorable weather conditions.
4. Moisture condition or dry fill material as required to obtain specified moisture content limits.
   a. Material which is too wet to allow proper compaction, as determined by testing agency, may be spread and permitted to dry assisted by disking, harrowing, or pulverizing.
5. Place fill material using spreading equipment capable of obtaining uniform loose lift thickness.
6. Compact fill material using equipment appropriate to the material being compacted, as determined by testing agency.
7. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed fill area is as specified.

8. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
9. In excavations where testing agency determines that subgrade material is unacceptable, remove unacceptable material and backfill in accordance with procedures determined by testing agency.
10. Minimize construction traffic, including foot traffic, from pavement finished subgrades in order to prevent unnecessary disturbances of subgrade materials.
    a. If testing agency determines that finished subgrades have been disturbed, remove disturbed areas and replace and recompact to required density as directed by testing agency.
    b. If testing agency determines that rutting has occurred, excavate 6 inches, or other depth as directed by testing agency, of subgrade material and recompact as specified for affected area.
    c. Testing agency shall be present during compaction of material.

B. In cut areas below pavements requiring less than 12 inches of fill to obtain finish subgrade elevations, and a lateral distance of 5 feet outside pavement areas, excavate existing material to a depth of not less than 6 inches below bottom of pavement subbase course.
1. Proof-roll subgrade and repair as required in paragraph 3.8.E below, then scarify to a depth of 6 inches to result in a surface free from ruts, hummocks, and other uneven features which, in the opinion of the testing agency, would prevent uniform compaction by the equipment proposed for use.
    a. Moisture condition subgrade to achieve moisture content specified in this Section.
    b. Compact to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698.
        1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
        2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
2. After scarifying, moisture conditioning, and recompacting, backfill areas using approved materials placed in loose lifts not exceeding 8 inches.
    a. compact each lift to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698.
        1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
        2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
3. Protect excavations from excessive wetting and drying during construction.
    a. Remove water entering excavation, and remove disturbed or softened soil.
4. Maintain subgrade moisture content within specified range until pavements are installed.
    a. Rework non-complying area as required to achieve specified requirements as directed by testing agency.
    b. Recompact and retest until required density and moisture content is obtained.

C. In areas below pavements requiring 12 inches or more of fill to obtain finish subgrade elevations, and a lateral distance of 5 feet outside pavement areas, proofroll existing subgrade

in presence of testing agency using a fully loaded tandem axle dump truck or similar type of pneumatic tired equipment with a minimum gross weight of 20 tons.

1. Remove soft areas as directed by testing agency and recompact in loose 9 inch lifts to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698.
    a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
    b. When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
2. After proofrolling operations are performed and observed soft areas repaired, place approved material in loose lifts not exceeding 8 inches.
    a. Compact each lift to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698.
        1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
        2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
3. Fill operations shall continue in compacted layers until finish subgrade elevations have been obtained.
    a. Compact each lift to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698.
        1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
        2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
4. Protect excavations from excessive wetting and drying during construction.
    a. Remove water entering excavation, and remove disturbed or softened soil.
5. Maintain subgrade moisture content within specified range until pavements are installed.
    a. Rework non-complying area as required to achieve specified requirements as directed by testing agency.
    b. Recompact and retest until required density and moisture content is obtained.

D. Tolerances
    1. Top surface of finish subgrade under paved areas: Plus or minus ¼ inch from required elevations.

E. Immediately prior to placement of pavement subbase course and pavements, proofroll subgrade in presence of testing agency using a fully loaded tandem axle dump truck or similar type of pneumatic tired equipment with a minimum gross weight of 20 tons.
    1. Remove soft areas as directed by testing agency and recompact in loose 9 inch lifts to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698.

a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
b. When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

3.09 GENERAL SITE FILL

A. General:
1. Testing agency shall be present during placement and compaction of fill material.
2. Fill material shall not be placed, spread, or rolled while the material is frozen of thawing, or during unfavorable weather conditions.
3. Moisture condition or dry fill material as required to obtain specified moisture limits.
4. Material which is too wet to allow proper compaction, as determined by testing agency, may be spread and permitted to dry assisted by dishing, harrowing, or pulverizing.
5. Place fill material using spreading equipment capable of obtaining uniform loose lift thickness.
6. Compact fill material using equipment appropriate to the material being compacted, as determined by testing agency.
7. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed fill area is as specified.
8. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.

B. Perform grading to the contours and elevations indicated on Drawings:
1. Uniformly grade areas to a smooth surface, free from irregular surface changes.
2. Provide a smooth transition between existing adjacent grades and new grades.

C. Place general fill material in systematic and uniform horizontal lifts not exceeding the following loose-depth-measurements:
1. For fill material to be compacted with heavy compaction equipment: 9 inches.
2. For fill material to be compacted with hand operated tampers: 4 inches.

D. Under sidewalks and ramps compact each lift of material to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698
1. In other areas, compact each lift of material to a minimum of 90 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698
a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
b. When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework on-complying area as required to achieve specified requirements.

E. Bench existing slopes horizontal sections equal in width to equipment used.

F. Where embankments, regardless of height, are placed against hillsides or existing embankments having a slope of steeper than 1 vertical to 5 horizontal, bench or step existing slope in approximately 24 inch rises:
1. Place fill in lifts not exceeding 9 inches in loose-depth-measurement
2. Compact material bladed out, bottom area which was cut to form benches, and fill material being placed, to a minimum of 95 percent of the material's maximum Standard

Proctor dry density with a moisture content between -2 and +3 percent above optimum moisture content in accordance with ASTM D698.

a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
b. When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

G. Remove surplus materials from Site, at no increase in Contract Sum or extension of Contract Time.
1. Submit an acceptable agreement with the property owner on whose property the material is placed.

H. Tolerances:
1. Top surface of finish subgrade under paved areas: Plus or minus ¼ inch from required elevations.
2. Top surface of finish subgrade under unpaved surfaces: Plus or minus ½ inch from required elevations.

3.10 INSTALLATION OF GRANULAR FILL

A. Immediately prior to placement floor slab granular base, testing agency will evaluate subgrade to determine whether moisture content is within specified range, and whether subgrade has been disturbed.
1. In areas where testing agency determines subgrade is not within specified moisture content range, remove non-complying areas and replace and recompact to required density, within specified moisture content range, as directed by testing agency.
a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
b. When test indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
2. If testing agency determines that rutting has occurred or other detrimental conditions exist, excavate 6 inches, or other depth as directed by testing agency, of subgrade material and recompact as specified for affected area.
a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
b. When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

B. Place granular fill in equal continuous layers not exceeding 6 inches.
1. Compact granular fill using heavy vibrating equipment, in 3 passes, to achieve a total compacted thickness of 4 inches in presence of Owner's representative or testing agency.
2. Compact granular fill in confined areas using a combination of manually operated vibratory plates and "wacker" compaction equipment.

C. Tolerances:
1. Top surface of finish subgrade under slabs-on-grade: Plus or minus ¼ inch from required elevations.

3.11 INSTALLATION OF PAVEMENT SUBBASE COURSE

A. Place pavement subbase course in equal continuous layers not exceeding 6 inches.
   1. Compact granular fill for pavement and sidewalk subbase course to a minimum of 95 percent of the material's maximum standard proctor dry density in accordance with ASTM D698.
   2. Compact granular fill in confined areas using a combination of manually operated vibratory plates and "wacker" compaction equipment.
   3. Qualitative tests shall be taken after the compaction of each layer of fill by testing agency.

B. Tolerances:
   1. Top surface of finish subgrade under paved areas: Plus or minus ¼ inch from required elevations.

3.12 BEDDING

A. Place and compact bedding course on trench bottoms and where indicated on Drawings.
   1. Install materials in continuous layers not exceeding 6 inches compacted depth.

B. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Install bedding to a depth of 6 inches below bottom of pipe bell or conduit, to an elevation of 6 inches above pipe or conduit.

D. Compact bedding materials by slicing with a shovel and compacting with vibratory plates and "wacker" compaction equipment.

E. Support pipe and conduit during placement and compaction of bedding fill.

3.13 INSTALLATION OF BACKFILL

A. Backfill excavations promptly, but not before completion of the following:
   1. Surveying location of underground utilities for Record Documents
   2. Testing, inspecting, and approval of underground utilities
   3. Removal of concrete forms
   4. Removal of lumber, rock, paper, and other debris from areas to be backfilled
   5. Removal of temporary shoring, bracing, and sheeting

B. Backfill areas to contours and elevations indicated on Drawings, using unfrozen backfill material
   1. Do not backfill over porous, wet, frozen, thawing, or spongy surfaces
   2. Do not backfill during unfavorable weather conditions
   3. Moisture condition or dry backfill material as required to obtain specified moisture content limits
      a. Material which is too wet to allow proper compaction, as determined by testing agency
   4. Place backfill material using equipment capable of obtaining uniform loose lift thickness
   5. Compact backfill material using equipment appropriate to the material being compacted, as determined by testing agency
   6. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously laced backfill areas is as specified
   7. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
   8. Compaction in lawn and planter areas is 85% maximum.

C. Backfilling of curbs, slabs-on-grade, and other structures whose foundation is unprotected from water shall be accomplished as soon as forms are removed, to eliminate possibility of softening of subbase below structure

D. Backfill foundation walls with granular material, not less than 24 inches in width, to an elevation of 2 feet below finish grade.
   1. Backfill simultaneously on each side of unsupported foundation walls.
   2. Backfill upper 2 feet using General Fill Material.

E. Backfill trenches to contours and elevations indicated on Drawings, using unfrozen backfill material.
   1. Do not backfill over porous, wet, frozen, or spongy surfaces.
   2. Do not backfill during unfavorable weather conditions.
   3. Moisture condition or dry backfill material as required to obtain specified moisture content limits.
      a. Material which is too wet to allow proper compaction, as determined by testing agency, may be spread and permitted to dry assisted by disking, harrowing, or pulverizing.
   4. Place backfill material using equipment capable of obtaining uniform loose lift thickness.
      a. Employ a placement method of backfill operations which does not disturb or damage utilities in trenches.

F. Backfill trenches that carry below or pass under footings and that are excavated within 18 inches of footings with concrete.
   1. Place concrete to elevation equal to bottom of footings.

G. Compaction of General Backfill
   1. Maintain optimum moisture content of backfill materials to attain required compaction density.
   2. General Fill Materials used for backfill shall be placed in lifts not exceeding 9 inches in loose-depth-measure and compacted as specified for General Site Fill
   3. Granular Fill Materials used for backfill shall be placed in lifts not exceeding6 inches in loose-depth-measure and compacted as specified for Granular Fill.
   4. Field density tests shall be taken after the compaction of each layer of backfill by testing agency.
      a. When tests indicate that any layer of backfill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

H. Compaction of Trench Backfill
   1. Compact backfill material using equipment appropriate to the material being compacted, as determined by testing agency.
   2. Maintain optimum moisture content of backfill materials to attain required compaction density.
   3. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed backfill area is as specified.
   4. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
   5. General Fill Material used for backfill shall be placed in lifts not exceeding 4 inches in loose-depth-measure with each lift compacted as specified in this section.
   6. MoDOT Standard Specification for Highway Construction Type 5 aggregate used for backfill shall be placed in lifts not exceeding 6 inches in loose-depth-measure and compacted to a minimum of 97 percent of the material's maximum Standard Proctor dry density with a moisture content near optimum in accordance with ASTM D698.

7. Field density tests shall be taken after the completion of each layer of backfill by testing agency.
    a. When tests indicate that any layer of backfill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

I. Slope grade away from building not less than 12 inches in 10 foot for a distance of not less than 6 feet outside of building lines.
1. Make grade changes gradual.
2. Blend slopes into level areas.
3. Remove surplus materials from Site, at no increase in Contract Sum or extension of Contract Time
4. Submit an acceptable agreement with the property owner on whose property the material is placed

J. Tolerances:
1. Top surface of finish subgrade under paved areas: Plus or minus ¼ inch from required elevations
2. Top surface of finish subgrade under unpaved areas. Plus or minus ½ inch from required elevations

3.14 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Geotechnical Engineer.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 6938, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.15 PROTECTION

A. Protect newly graded areas from freezing and erosion.

B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.

C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
   1. Testing agency shall be present during compaction of material.

END OF SECTION

SECTION 312319
DEWATERING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes construction dewatering.

B. Related Sections include the following:
   1. "Earth Moving" for excavating, backfilling, site grading and for site utilities.

1.03 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
   1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
   4. Remove dewatering system if no longer needed.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.05 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Design Professional and then only after arranging to provide temporary utility services according to requirements indicated.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
   1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
   2. The geotechnical report is included elsewhere in the Project Manual.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
   1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
   2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.02 INSTALLATION

A. Provide an adequate system to lower and control ground water to permit excavation, and placement of fill materials on dry subgrades.
   1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

B. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

C. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
   1. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION

SECTION 321313
CONCRETE PAVING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Driveways.
   2. Roadways.
   3. Parking lots.
   4. Curbs and gutters.
   5. Walks.

B. Work in public right-of-way: All work in public right-of-way shall be performed per City Standards and Specifications.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each exposed product and for each color and texture specified.

C. Other Action Submittals:
   1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   2. Aggregates: Aggregates must be supplied from a source previously tested and certified by MoDOT as meeting "Aggregates for Concrete" requirements in Section 1005 of MoDOT Standard Specifications. Aggregate shall be sound and durable and meet ASTM C586.

1.03 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

PART 2 PRODUCTS

2.01 STEEL REINFORCEMENT

A. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

B. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.

C. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A; coated, deformed.

D. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.02 CONCRETE MATERIALS AND MIXTURES

A. Portland cement concrete shall conform to MoDOT 501 and 1005 with the following modifications:
   1. All portland cement concrete shall be air entrained with 6% (± 1%) minimum air content.
   2. The use of calcium chloride is not permitted.
   3. The allowable slump shall be not more than 4 inches.
   4. The minimum 28-day compressive strength shall be 4,000-psi.
   5. Aggregate:
      a. The combined maximum weight of flint and chert shall be 1% of the weight of coarse aggregate.
      b. The maximum weight of lignite shall be 0.07% of the weight of the fine aggregate.

2.03 CURING MATERIALS

A. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.04 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.05 WHEEL STOPS

A. Wheel Stops: Precast, air-entrained concrete.
   1. Dowels: Galvanized steel, 3/4 inch (19 mm) in diameter, 10-inch (254-mm) minimum length.
   2. Adhesive: As recommended by wheel stop manufacturer for application to concrete pavement.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

B. Remove loose material from compacted subbase surface immediately before placing concrete.

C. Prior to concrete paving, Contractor shall prepare mockup for concrete pavement and sidewalks. Mockup to include a minimum of 100 square feet of paving. Mockup may be installed "in-place" and must demonstrate the proposed joint types, reinforcement, sealant, and saw-cutting. Prepare mockup for Owner review and approval, prior to concrete paving.

3.02 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.03 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.04 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.05 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

B. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, placing, and consolidating concrete.

C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed paving surface with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.06 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.07 COLD AND HOT WEATHER CONCRETE PLACEMENT

A. Cold Weather Concrete:

1. Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when the descending air temperature in the shade and away from artificial heat reaches thirty-five (35°) degrees F. Concrete operations may be resumed when the ascending air temperature in the shade and away from artificial heat reaches thirty five (35°) degrees F.
2. When concrete work is authorized during cold weather, the concrete may be heated in accordance with ACI specifications. The temperature of the concrete shall be not less than sixty (60°) degrees F and not more than eighty (80°) degrees F at the time of placement in the forms.
3. No concrete shall be placed on frozen subgrade. Sudden cooling of concrete shall not be permitted. Concrete exposed to frost action or freezing weather shall be removed and replaced at the Contractor's expense.

4. A sufficient supply of approved blanketing material shall be provided and placed on all concrete placed between November 1 and April 1 and at other times when the ambient air temperature is expected to drop below forty (40°) degrees F. Blanketing materials shall protect the concrete and maintain a minimum temperature of forty (40°) degrees F in the concrete as measured on the surface. Concrete shall be covered for at least four days.

B. Hot Weather Concrete:
1. The provisions of this section shall apply to all concrete work, which is done when the air temperature is above eighty (80°) degrees F at the time of placement. The temperature of the concrete, when placed, shall not be high enough to cause excessive loss of slump, flash set or cold joints. Forms, reinforcing and sub-grade surfaces against which the concrete is to be placed shall be wetted down immediately before placement. In no case shall the temperature of the concrete, when placed, exceed ninety (90°) degrees F.
2. When the air temperature exceeds ninety (90°) degrees F and as soon as practicable without causing damage to the surface finish, all exposed concrete shall be kept continuously moist by means of fog sprays, wet burlap, cotton mats, or other means acceptable to the Engineer at no expense to the Owner. This cooling with water shall be in addition to the initial sealing by membrane curing compound.
3. No concrete shall be placed when the air temperature is above ninety-five (95º) degrees F.

3.08 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by curing compound.

3.09 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
1. Elevation: 1/8 inch (3 mm).
2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
3. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/4 inch (6 mm).
4. Joint Spacing: 3 inches (75 mm).
5. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
6. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.10 WHEEL STOPS

A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.

B. Securely attach wheel stops to paving with not less than two [**galvanized-**]steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 OPENING TO TRAFFIC

A. The concrete pavement shall not be opened for light traffic until the concrete is at least 72 hours old and has attained a minimum compressive strength of 3000 pounds per square inch. The pavement shall not be opened to all types of traffic until the concrete is at least 72 hours old and has attained a minimum compressive strength of 3500 pounds per square inch. If high early strength concrete is used, the pavement may be opened to all types of traffic when the concrete has attained a minimum compressive strength of 3500 pounds per square inch. Pavement shall be cleaned prior to opening to traffic

3.12 FIELD QUALITY CONTROL

A. Testing Agency: The Owner will engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.

B. Testing Services: Testing shall be performed according to the following requirements:
   1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C 172, except modified for slump to comply with ASTM C 94.
   2. Slump: ASTM C 143; one test at point of placement for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
   3. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.
   4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each set of compressive-strength specimens.
   5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
   6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd., but less than 100 cu. yd., plus one set for each additional 100 cu. yd. One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.
   7. In-place pavement thickness will be determined by test core samples. One core sample will be taken for every 1,000 square yard or less of installed pavement, with no fewer than 3 cores taken.
   8. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.
   10. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi.

C. Test results shall be reported in writing to Owner, Design Professional, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and

class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Design Professional but will not be used as the sole basis for approval or rejection.

E. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Design Professional. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.13 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Design Professional.

B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373
CONCRETE PAVING JOINT SEALANT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Cold-applied joint sealants.

B. Related Sections:
   1. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.02 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Pavement-Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
   3. Joint-sealant formulation.
   4. Joint-sealant color.

1.03 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.

C. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.
   1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

D. Preinstallation Conference: Conduct conference at Project site.

1.05 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C)
   2. When joint substrates are wet.

3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 PRODUCTS

2.01 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Design Professional from manufacturer's full range color.

2.02 COLD-APPLIED JOINT SEALANTS

A. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.
1. Suggested inexhaustive manufacturers list:
a. Pecora Corporation.
b. Sika Corporation.
c. BASF.

2.03 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

2.04 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of joint-sealant backings.
   2. Do not stretch, twist, puncture, or tear joint-sealant backings.
   3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place joint sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
   1. Remove excess joint sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.04 CLEANING

A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 323113
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Polymer-coated steel framework: chain-link fences
   2. Gates: horizontal slide

1.02 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Show locations, components, materials, dimensions, sizes, weights, finishes of components, installation and operational clearances, gate swings, and details of post anchorage and attachment and bracing.

C. Samples: For polymer coating on framing and accessories.

D. Maintenance Data: For polymer finishes.

E. Warranty: sample of special warranty

PART 2 PRODUCTS

2.01 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI product Manual and with requirements indicated below:
   1. Fabric Height: 96 inches
   2. Wire Fabric: Wire with a diameter of 0.120 inch.
      a. Mesh Size: 2 inches
      b. Zinc-Coated Fabric: ASTM A 392, Type II Class 1, 1.2 oz/sq. ft. with zinc coating applied after weaving.
   3. Selvage: Knuckled at both selvages.

2.02 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:
   1. Fence Height: 96 inches
   2. Light Industrial Strength: Material Group IC-L, round steel pipe, electric-resistance-welded pipe.
      a. Line Post: 2.375 inches
      b. End, Corner and Pull Post: 4.0 inches.
   3. Horizontal Framework Members: Top and bottom rails complying with ASTM F1043.
      a. Top and bottom rail size: 1.625 inches
   4. Brace Rails: Comply with ASTM F 1043.
   5. Metallic Coating for Steel Framing:
      a. Type A zinc coating.

2.03 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:

1. Type II, zinc coated with minimum coating weight matching chain-link fabric coating weight.

2.04 SWING GATES

A. General: Comply with ASTM F 900 for gate posts and single and double swing gate types.
   1. Gate Leaf Width: 36 inches or as indicated on drawing.
   2. Gate Fabric Height: 96 inches.

B. Pipe and Tubing:
   1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
   2. Gate Posts: Round tubular steel.
   3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded.

D. Hardware:
   1. Hinges: 180-degree outward swing.
   2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
   3. Padlock and Chain: As required by Owner.
   4. Lock: Manufacturer's standard internal device furnished in lieu of gate latch.
   5. Closer: Manufacturer's standard.

2.05 FITTINGS

A. General: Comply with ASTM F 626.

B. Finish:
   1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. zinc.

2.06 CAST-IN-PLACE CONCRETE

A. General: Comply with ACI 301 for cast-in-place concrete; materials consisting of portland cement complying with ASTM C 150, aggregates complying with ASTM C 33, and potable water.
   1. Concrete Mixes: Normal-weight concrete air entrained with not less than 3000-psi (20.7-MPa) compressive strength (28 days), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum size aggregate.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated. Do not begin installation before final grading is completed, unless otherwise permitted by Engineer.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.

C. Post Setting: Hand-excavate holes for post foundations in firm, undisturbed or compacted soil.
   1. Concrete Footings: Place concrete around posts and vibrate or tamp for consolidation. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured. Set the following post types in concrete footings and protect portion of posts aboveground from concrete splatter:
      a. Terminal.

b. Line; Using mechanical devices to set line posts per ASTM F 567 is not permitted.
c. Gate.
d. Gate operator-mounting.

D. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment s as indicated on drawings.

E. Line Posts: Space line posts uniformly at 10 feet o.c.

F. Intermediate Rails: Install in one piece, spanning between posts, using fittings, special offset fittings, and accessories.

G. Bottom Rails: Install, spanning between posts, using fittings and accessories.

H. Chain-Link Fabric: Apply fabric to outside of enclosing framework.

I. Tie Wires: Attach wire to chain-link fabric per ASTM F 626. Tie fabric to line posts at maximum interval of 12 inches (304 mm) o.c. and to braces at maximum interval of 24 inches (609 mm) o.c.

J. Gate Installation: Install gates level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust gate to operate smoothly, easily, and quietly throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 329119
LANDSCAPE GRADING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Final grade topsoil for finish landscaping.

B. Related Sections:
   1. Section 311000 – Site Clearing.
   2. Section 312000 – Earth Moving.

1.02 SUBMITTALS

A. Product Data: Manufacturer's specifications and technical data on soil stabilizers.

B. Certifications: Submit statement certifying location of property from which imported topsoil is proposed to be obtained:
   1. Include names and addresses of property owners, depth of topsoil to be stripped, and crops grown during last 2 years.

1.03 QUALITY ASSURANCE

A. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project.

PART 2 PRODUCTS

2.01 MATERIALS

A. Contractor shall install a minimum of 4 inches of topsoil on all disturbed areas. Contractor may use a combination of acceptable stockpiled topsoil and/or imported topsoil.

B. Stockpiled Topsoil: ASTM D5268, fertile, friable, natural silty clay loam, surface soil, reasonably free (less than 5 percent of total volume) of subsoil, clay lumps, brush, weeds, and other litter, and free of roots, stumps, stones larger than 3/8 inch, in any dimension, and other extraneous or toxic matter harmful to plant growth, approved by Owner's testing agency.
   1. Acidity range (ph): 5.5 and 7.5.
   2. Organic matter content: 4 to 25 percent.
   3. Remove particles larger than 3/8 inch in size.
   4. Process, clean, and prepare existing topsoil to comply with above specified criteria.

C. Imported Topsoil: ASTM D5268, fertile, friable, natural silty clay loam, surface soil, reasonably free (less than 5 percent of total volume) of subsoil, clay lumps, brush, weeds, and other litter, and free of roots, stumps, stones larger than 3/8 inch, in any dimension, and other extraneous or toxic matter harmful to plant growth, approved by Owner's testing agency.
   1. Acidity range (ph): 5.5 and 7.5.
   2. Organic matter content: 4 to 25 percent.
   3. Obtain topsoil from local sources or from areas having similar soil characteristics to that found at Project Site.
      a. Obtain topsoil from naturally, well-drained sites, where topsoil occurs in a depth of not less than 4 inches.
         1) Do not obtain from bogs or marshes.
      b. Designate proposed topsoil borrow area and provide verification by a testing agency that the soil in the area meets imported topsoil criteria.
   4. Remove particles larger than 3/8 inch in size.
   5. Process, clean, and prepare imported topsoil to comply with specified criteria.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
   1. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protection:
   1. Protect trees, shrubs, lawns, other plant growth, and other features indicated on Drawings to remain.
   2. Protect bench marks, monuments, existing structures, existing fences, existing roads, existing sidewalks, existing paving, and existing curbs from damage and displacement.

B. Preparation:
   1. Use all means necessary to control dust on and near Work if such dust is caused by performance of the work of this Section, of it resulting from the condition in which Project Site is left by Contractor.
   2. Moisten surfaces as required to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other Work on Project Site.
   3. Identify required lines, levels, contours, and datum.
   4. Identify above and below grade utilities.
   5. Provide and maintain positive surface drainage.
   6. Loosen subgrade not less than 4 inches.
   7. Remove stones measuring over 3/8 inch in any dimension.
   8. Remove sticks, rubbish, and other extraneous matter.

3.03 INSTALLATION

A. Grade Project Site to uniform slopes between points for which finish grades are indicated on Drawings, or between such points and existing established grades.
   1. Provide vertical curves or roundings at abrupt changes in slopes.
   2. Grade using topsoil which is relatively dry.
   3. Grade during dry weather.

B. Remove stone, roots, grass, weeds, debris and foreign matter larger than 3/8 inch in size from topsoil.

C. Fine grade topsoil to eliminate rough or low area.

D. Manually spread topsoil around trees, building, and paving to prevent damage.

E. Roll placed topsoil.
   1. Total thickness of topsoil after compaction shall be not less than 6 inches.
   2. Import topsoil as required to achieve required total compacted thickness.

F. If surplus topsoil occurs, deposit on Site at area designated by Owner's Representative.

G. Tolerances: Top of topsoil: Plus or minus 0.10 foot from grades indicated on Drawings.

END OF SECTION

SECTION 329219
SEEDING

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section covers furnishing and sowing seed, compacting, mulching, and establishing turf in accordance with this specification at the locations shown on the drawings.

B. Furnish all labor, tools, equipment, material, and perform all operations necessary and incidental to proper execution and completion of all work in accordance with the drawings and specifications.

C. Contractor shall seed all disturbed areas.

PART 2 PRODUCTS

2.01 SEED

A. All seed shall be furnished in sealed containers. Seed that has become wet, moldy, or otherwise damaged in transit or storage will not be acceptable. The seed mixture shall be as follows: Submit all seed certificates to the Owner's Representative.

2.02 SEED MIXTURES

A. Hybrid Fescue Mix "Rebel II" or "Falcon"
   1. Hybrid Fine Fescue:
      a. Minimum % Pure Live Seed: 95%
      b. % Germ.: 85%
      c. Rate of application per 1000 square feet area: 7 pounds
   2. Kentucky Bluegrass
      a. Minimum % Pure Live Seed: 80%
      b. % Germ.: 70%
      c. Rate of application per 1000 square feet area: 1 pound.

2.03 MULCH

A. Straw mulch shall be the thrashed plant residue of oats, wheat, barley, or rye from which grain has been removed or optional wood cellulose fiber applied by the hydro-mulching method. The straw shall be free of prohibitive weed seeds as stated in the Missouri Seed Law, and shall be relatively free of all other obnoxious and undesirable seeds.

B. Commercial grade wood cellulose fiber. Nominal moisture content not exceeding 12 percent.

2.04 SOIL FOR REPAIRS

A. Soil for filling areas to be repaired shall be topsoil free of large stones, clods, roots, stumps, or other materials that would interfere with subsequent seeding, compacting, or establishment.

PART 3 EXECUTION

3.01 GENERAL

A. Areas to be seeded are all areas disturbed by construction not covered by pavement, structures or landscape.

B. Soil preparation, applying fertilizer, finish grading, removal of weed growth, and all other operations necessary to prepare the seed bed prior to sowing seed is covered in section FINE GRADING AND FERTILIZING. The seed bed must be in a loose, fine, well-aggregated condition and approved by the owner's representative prior to seeding.

C. Skipped areas wider than the distance between drills, in case of drilling operations or areas averaging more than four (4) inches in width in the case of broadcasting operations shall be reseeded. Drill sowing is the preferred method.

3.02 SOWING SEED

A. All sowing of seed shall be completed between the dates of March 15 and May 30 for spring seeding; and August 15 and October 1 for fall seeding. Sowing delayed beyond the specified dates, and due to circumstances beyond the contractor's control, may be continued upon written approval.

B. The sowing may be stopped when satisfactory results are not likely to be obtained due to drought conditions, excessive moisture, high wind or other unfavorable conditions. Sowing of seed shall be resumed only when conditions are again favorable or when alternative or corrective measures and approved procedures have been adopted.

C. Broadcast Sowing: Seed shall be broadcast by approved sowing equipment where drill sowing is not practical, at a rate which will provide not less than the minimum quantity of seed stated in these specifications. The seed shall be uniformly distributed over the designated areas. Broadcast sowing shall not be done when the wind exceeds a velocity of five (5) miles per hour. The seed shall be placed ¼" to ⅜" in the soil by means of a harrow or cultipacker.

3.03 HYDROSEEDING

A. Mix specified seed, fertilizer and wood cellulose fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic.
   1. Use of 45 pounds of wood cellulose fiber mulch per 1,000 square feet of area.

B. Apply slurry uniformly to all areas to be seeded. Rate of application as required to obtain specified seed sowing rate.

C. Use 4' x 8' sheets of plywood or other suitable device along all pavement edges, structures, and fences and around plants to prevent over-spray of mulch onto these surfaces.

3.04 COMPACTING

A. Not applicable if hydroseeding.

B. Immediately after the sowing operations have been completed, the entire area shall be compacted by means of a cultipacker, roller or other approved equipment, in order to reduce air pockets to a minimum. When a cultipacker, or other approved equipment that leaves a roughened surface is used, the final rolling shall be along the contour and at right angles to the prevailing winds to reduce dust. If the mulching operation can be accomplished the same working day the area is seeded, compacting the seed and anchoring the mulch may be done at the same time.

3.05 MULCHING

A. Not applicable if hydroseeding.

B. Straw mulch shall be spread uniformly in a continuous blanket, using not less than 2,000 lb. Per acre or one (1) bale per 1,000 square feet, approximately 4 to 5 straws deep and having soil show through mulch. Mulching shall start at the windward side of relatively flat areas, or at the upper part of a steep slope, and shall continue until the area is completely covered.

C. Immediately following spreading of the straw, the material shall be anchored to the soil by a V-type wheel land packer, a disc harrow set to cut only slightly, or other suitable equipment which will secure the straw firmly in the ground to form a soft binding mulch and prevent loss or bunching by the wind.

3.06 MAINTENANCE

A. Begin maintenance of new turf areas immediately after each area is planted and continue until accepted as specified.

B. Maintain turf by watering, fertilizing, weeding, rolling, regrading and replanting as required to establish a smooth, acceptable turf, free of eroded or bare areas.

C. Remulch with new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose. Anchor as required to prevent displacement.

D. Replant bare areas with same materials as originally specified.

E. Watering: Watering of seeded areas for germination and establishment is not required. However, the Contractor shall unconditionally guarantee an acceptable stand of grass in all seeded areas. If the Contractor elects to water, provide and maintain temporary piping, hoses, watering equipment, and vehicles as required to convey water and to keep turf areas uniformly moist as required for proper growth and acceptability.

F. Program watering schedule to prevent puddling, water erosion and displacement of seed or mulch.

3.07 MAINTENANCE FERTILIZING

A. 6 to 8 weeks after the original seeding and prior to the first mowing, the Contractor shall apply maintenance fertilizer. Analysis shall be as recommended by the soil test.

3.08 REPAIRS OF SEEDED AREAS

A. When the surface has become gullied or otherwise damaged during the period of establishing turf, the affected area shall be repaired to reestablish the grade and the condition of the soil, and shall be reseeded at the original seed rate. Fill material shall be placed and compacted in six (6) inch lifts. Reseeding shall be done in a manner that will cause a minimum of disturbance to the existing stand of grass.

3.09 ACCEPTANCE

A. When work is completed and seeded areas are in an acceptable condition as specified herein, Owner will, upon request, make an inspection to verify acceptability.
   1. Immediately prior to an inspection, Contractor shall mow the area to be inspected for acceptance. The Owner will do mowing for maintenance.

B. Replant rejected work and continue specified maintenance until reinspected by Owner and found acceptable.

C. Seeded areas will be acceptable provided a uniform stand of specified grass is established that is reasonably free of weeds, bare spots, and surface irregularities, as determined by the Owner and is at least 2 inches tall.

3.10 CLEANUP

A. Promptly remove soil and debris created by seeding work from paved areas and overspreads of hydroseeding mulch from pavement, fences and structures. During the progress of the work, clean wheels of vehicles before leaving site to avoid tracking soil onto surface of roads, walks, or other paved areas.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 333100
SANITARY UTILITY SEWERAGE PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Sanitary sewage piping.
   2. Manholes.
   3. Connection of building sanitary drainage system to municipal sewers.
   4. Related accessories.

B. Related Sections:
   1. Section 312000 – Earth Moving.

1.02 SUBMITTALS

A. Product Data: Manufacturer's specifications and technical data on the following:
   1. Piping.
   2. Fittings.
   3. Cleanouts.

B. Shop Drawings: Indicate dimensions, description of materials, general construction, specific modifications, component connections, anchorage methods, and installation procedures, plus the following specific requirements.
   1. Include manholes, frames, and covers.

C. Contract Closeout Submittals:
   1. Project Record Documents.
      a. Contractor to provide as-built survey, prepared by Registered Land Surveyor, that indicates the exact location, top elevations, flow lines and pipe sizes of all structures.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.

B. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following:
   1. Not less than 3 years experience with systems.
   2. Successfully completed not less than 5 comparable scale projects using this system.

C. Regulatory Requirements:
   1. Comply with requirements of American Public Works Association.
   2. Comply with requirements of City.

D. Certificates: Certification from precast manufacturer that Con^{mic}Shield® with CONTINT was used in the fabrication of sewer manhole.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.

B. Precast concrete sections shall not be delivered to the job until the concrete control cylinders have attained a strength of at least 80 percent of the specified minimum.

C. Precast concrete sections shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint sections.

D. Precast concrete sections shall be inspected when delivered. All cracked or otherwise visibly defective units will be rejected. City reserves the right to inspect the production of the units at the manufacturing plant.

E. Storage and Protection: Comply with manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. Polyvinyl Chloride (PVC) Pipe and Fittings: ASTM D3034, SDR 21.
   1. Joints: Pipe and fittings shall have elastomeric gasket joints providing a watertight seal when tested in accordance with ASTM D3212. Gaskets shall conform to ASTM F477. Solvent welded joints shall not be permitted.

B. Concrete:
   1. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
      a. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
      b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420-MPa) deformed steel.
   2. Con^{mic}Shield® with CONTINT shall be added to all precast and cast-in-place manholes in accordance with the manufacturer's recommendations.
      a. Cast-in-place concrete invert fill and collars inside the manhole shall contain Con^{mic}Shield® with CONTINT per manufacturer's recommendation.

2.02 COMPONENTS

A. Manholes: ASTM C478, precast reinforced concrete.
   1. Base section:
      a. Floor slab: 8 inch thick, unless otherwise indicated on drawings.
      b. Walls: 6 inch thick, unless otherwise indicated on drawings.
      c. Base riser section: 6 inch thick, unless otherwise indicated on drawings.
   2. Riser section: 48 inch diameter unless otherwise indicated on Drawings, with 6 inch thick walls.
   3. Top section: Concentric cone, eccentric cone, or flat slab type, as indicated on Drawings.
      a. Top of cone to match grad rings.
   4. Grade rings: Reinforced concrete rings, 4 to 9 inches thick.
   5. Gasket: O-ring, double ring, or preformed bitumastic sealant.
   6. Steps: Steel reinforced polypropylene plastic steps per ASTM 4101, cast into base, riser and top sections at 12 inch intervals.
   7. Frame and cover: ASTM A48, Class 35B gray iron.
      a. Frame size: 24 inch inside diameter, by 9 inch riser with 4 inch width flange.
      b. Cover: 26 inch diameter, indented top design, with lettering "SANITARY SEWER" cast into cover.
   8. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
   9. Pipe connectors: ASTM C923, resilient type.
      a. Provide "boot" type nitrile rubber connections at locations indicated on Drawings.
   10. Con^{mic}Shield® with CONTINT shall be added to all precast manholes in accordance with the manufacturer's recommendations.
      a. Cast-in-place concrete invert fill and collars inside the manhole shall contain Con^{mic}Shield® with CONTINT per manufacturer's recommendation.

2.03 ACCESSORIES

A. Cleanouts: Cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy-duty, secured, scoriated cast-iron cover.

B. Underground Warning Tape: Polyethylene plastic tape with magnetic detectable conductor, 6 inches wide by 4 mils thick.
   1. Imprint warning tape with “CAUTION – SEWER SERVICE LINE BURIED BELOW” in large black letters.

C. Bedding Materials: As specified under Section 312000.

D. Fill Materials: As specified under Section 312000.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
   1. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Trenching: Comply with requirements of Section 312000.
   1. Grade trench bottom to provide smooth, firm, stable, and rock free foundation throughout length of pipe.
   2. Remove unstable, soft, and unsuitable materials from surface upon which pipe is to lay.
      a. Backfill with bedding materials.
   3. Shape bottom of trench to fit design of pipe.
      a. Fill unevenness with tamped bedding materials.
      b. Dig bell holes at each pipe joint to assure continuous bearing of pipe.

B. Install bedding material at trench bottom in accordance with Section 312000.
   1. Install bedding materials in continuous layers not exceeding 6 inches in compacted depth, to total depths indicated on Drawings.
   2. Compact bedding materials as specified under Section 312000.

C. Pipe Installation: Comply pipe manufacturer’s instructions.
   1. Install pipe beginning at low point of system, true to grades and alignment indicated on Drawings and unbroken continuity of invert.
   2. Install PVC pipe in accordance with ASTM D2855 and ASTM F447.
   3. Place bell ends or groove ends of piping facing upstream.
   4. Install gaskets in accordance with manufacturer’s instructions.
   5. Install bedding at sides and over top of pipe to minimum compacted thickness of 12 inches.
   6. Clean interior of piping as Work progresses.
   7. Maintain swab or drag line and pull past each joint as it is completed.
   8. Install plugs in ends of incomplete piping at end of each day and whenever Work stops.

D. Install manholes complete with accessories indicated on Drawings.
   1. Comply with ASTM C891.
   2. Form continuous concrete channel and benches between inlets and outlets.
   3. Install top of frames and covers flush with adjacent paved surfaces.
      a. Install top of frame 3 inches above adjacent landscaped surfaces.

E. Install clean-outs and extension from sewer pipe to clean-out at grade at locations indicated on Drawings.
   1. Set cleanout frame and cover in concrete pad, 18 inches by 18 inches by 12 inches deep, except at where location is in concrete paving.
   2. Set top of cleanout 1 inch above surrounding grade.
   3. Set top of cleanout flush with surrounding pavement.

F. Tap Connections:
   1. Make connections to existing sanitary sewer and underground to comply with requirements of this Section, as indicated on Drawings.

G. Install underground warning tape continuous buried 6 inches below finish grade, above pipe line.
   1. Coordinate with Section 312000.

H. Backfilling: Comply with requirements of Section 312000.

3.03 CLEANING

A. Flush piping between manholes and other structures if required by authority having jurisdiction.
   1. Remove collected debris.

3.04 FIELD QUALITY CONTROL

A. Tests:
   1. Perform testing of completed system in accordance with local authorities having jurisdiction.
   2. Perform the following tests in accordance with APWA Street Construction and Material Specifications, Division II, Section 2509.
      a. Infiltration-exfiltration air test.
      b. Deflection test.

B. Inspections:
   1. Perform inspections in accordance with APWA Street Construction and Material Specifications, Division II, Section 2509.
   2. Inspect interior of piping to determine whether line displacement or other damage has occurred.
   3. Make inspections after pipe between manholes and manhole locations has been installed and approximately 2 feet of backfill material in place.
      a. Reinspect at completion of Project.
   4. If inspections indicate poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and reinspect.
      a. Defects requiring correction include the following:
         1) Alignment: Less than full diameter of inside of pipe is visible between structures.
         2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
         3) Crushed, broken, cracked, or otherwise damaged piping.
         4) Infiltration: Water leakage into piping.
         5) Exfiltration: Water leakage from or around piping.

C. Video Inspections:
   1. Provide CCTV video footage of sanitary sewer lines to owner prior to substantial completion and acceptance by owner.

3.05 PROTECTION

A. Protect installed sewage system from damage and/or displacement until backfilling operation is complete.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 334100
STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Storm sewage piping.
   2. Junction boxes.
   3. Inlets.
   4. Yard drains.
   5. Related accessories.

B. Related Sections:
   1. Section 033000 – Cast-In-Place Concrete.
   2. Section 312000 – Earth Moving.
   3. Section 312316 – Excavation.
   4. Section 334613 – Foundation Drainage.

1.2 SUBMITTALS

A. Submit in accordance with Division 1 unless otherwise indicated.

B. Product Data: Manufacturer's specifications and technical data on the following:
   1. Piping.
   2. Fittings.
   3. Yard Drains.
   4. Cleanouts.

C. Shop Drawings: Indicate dimensions, description of materials, general construction, specific modifications, component connections, and installation procedures, plus the following specific requirements:
   1. Include junction boxes, inlets, frames, covers, and grates.

D. Contract Closeout Submittals: Submit in accordance with Division 1.
   1. Project Record Documents.
      a. Accurately record location of underground utilities, by horizontal dimensions from above grade permanent fixtures, elevations or inverts, and slope gradients.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.

B. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following:
   1. Not less than 3 years experience with systems.
   2. Successfully completed not less than 5 comparable scale projects using this system.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.

B. Storage and Protection: Comply with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforced Concrete Pipe: ASTM C76, Class III.
   1. Fittings: Same strength of adjoining pipe.
   2. Joints:
      a. Gaskets: Contractor has option of the following:
         1) ASTM C443, flat gaskets cemented to pipe tongue or spigot.
         2) ASTM C443 O-ring gaskets.
         3) ASTM C443 roll-on gaskets.

B. Polyvinyl Chloride (PVC) Pipe and Fittings: ASTM D3034, SDR 21.
   1. Solvent cement: ASTM D2564.

C. High Density Polyethylene (HDPE) pipe and fittings: AASHTO M252, Type S; AASHTO M294, Type S.

D. Concrete: Comply with requirements of Section 033000.

E. High Density Polypropylene Pipe (HDPP):
   1. Dual wall pipe and fittings 12 inch through 24 inch diameter shall conform to ASTM F2736. Triple wall pipe 30 inch through 60 inch shall conform to ASTM F2881, except as otherwise specified herein.
   2. Pipe shall be joined using a bell & spigot joint meeting the requirements of ASTM F2881 or AASHTO M330. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12- through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed by the manufacturer.
   3. Fittings shall conform to ASTM F2881 or AASHTO M330. Bell and spigot connections shall utilize a welded or integral bell and valley or inline gaskets meeting the watertight joint performance requirements of ASTM D3212.
   4. High Density Polyethylene Pipe (HDPE) is not equivalent to polypropylene pipe and shall not be considered as an acceptable substitute.

2.2 COMPONENTS

A. Junction Boxes: ASTM C858, precast reinforced concrete.
   1. Base section:
      a. Floor slab; 8 inch thick.
      b. Walls: 6 inch thick.
      c. Base riser section: 6 inch thick.
   2. Riser section: 48 inch diameter unless otherwise indicated on Drawings, with 6 inch thick walls.
   3. Top section: Concentric cone, eccentric cone, or flat slab type, as indicated on Drawings.
      a. Top of cone to match grade rings.
   4. Grade rings: Reinforced concrete rings, 4 to 9 inches thick.
   5. Gasket: ASTM C443, rubber.
   6. Steps: Cast iron steps, case into base, riser and top sections at 16 inch intervals.
   7. Frame and cover: ASTM A48, Class 35B gray iron.
      a. Frame size: 24 inch diameter, by 9 inch riser with 4 inch width flange.

b. Cover: 26 inch diameter, indented top design, with lettering “STORM SEWER” cast into cover.

8. Pipe connections: ASTM C923, resilient type.

B. Inlets: ASTM C858, precast reinforced concrete
1. Base section:
a. Floor slab: 8 inch thick.
b. Walls: 6 inch thick.
c. Base riser section: 6 inch thick.
2. Riser section: 48 inch diameter unless otherwise indicated on Drawings, with 6 inch thick walls.
3. Top section: Flat slab type.
a. Opening to match grade rings.
4. Grade rings: Reinforced concrete rings, 4 to 9 inches thick.
5. Gasket: ASTM C443, rubber.
6. Steps: Steel reinforced plastic steps, cast into base, riser and top sections at 16 inch intervals.
7. Pipe connections: ASTM C923, resilient type.

C. Yard Drains:
1. Size: 12 inches by 12 inches unless otherwise indicated on Drawings.
2. Body: ASTM F794, polyvinyl chloride (PVC).
3. Grate: ASTM A48, Class 30B cast iron, hinged type with traffic rating of H-20 approved for use in pedestrian applications.
4. Acceptable manufacturers and product:
a. Nyloplast America, Inc.: Inline Drain.
b. Comparable products of other manufacturers.

2.3 ACCESSORIES

A. Cleanouts: Cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy-duty, secured, scoriated cast-iron cover.

B. Underground Warning Tape: Polyethylene plastic tape, 6 inches wide by 4 mils thick.
1. Imprint warning tape with “CAUTION – SEWER SERVICE LINE BURIED BELOW” in large black letters.

C. Bedding Materials: As specified under Section 312000.

D. Backfill Materials: As specified under Section 312000.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Trenching: Comply with requirements of Section 312000.
1. Grade trench bottom to provide smooth, firm, stable, and rock free foundation throughout length of pipe.
2. Remove unstable, soft, and unsuitable materials from surface upon which pipe is to lay.
a. Backfill with bedding material.
3. Shape bottom of trench to fit design of pipe.

a. Fill unevenness with tamped bedding material.
b. Dig bell holes at each pipe joint to assure continuous bearing of pipe.

B. Install bedding material at trench bottom in accordance with Section 312000.
1. Install bedding materials in continuous layers not exceeding 6 inches in compacted depth, to total depths indicated on Drawings.
2. Compact bedding materials as specified under Section 312000.

C. Pipe Installation: Comply with pipe manufacturers instructions.
1. Install pipe beginning at low point of system, true to grades and alignment indicated on Drawings and unbroken continuity of invert.
2. Install concrete pipe in accordance with ACPA Concrete Piping Installation Manual.
3. Install polyethylene corrugated pipe in accordance with ASTM D2321.
a. Install fittings in accordance with manufacturer's instructions.
4. Install PVC pipe in accordance with ASTM D2855 and ASTM F402.
5. Place bell ends or groove ends of piping facing upstream.
6. Install gaskets in accordance with manufacturer's instructions.
7. Install bedding at sides and over top of pipe to minimum compacted thickness of 12 inches.
8. Clean interior of piping as Work progresses.
9. Maintain swab or drag line and pull past each joint as it is completed.
10. Install plugs in ends of incomplete piping at end of each day.

D. Install junction boxes complete with accessories indicated on Drawings.
1. Comply with ASTM C891.
2. Form continuous concrete channel and benches between inlets and outlets.
3. Install top of frames and covers flush with adjacent paved surfaces.
a. Install top of frame flush with adjacent landscaped surfaces, unless otherwise indicated on Drawings.

E. Install inlets complete with accessories indicated on Drawings.
1. Comply with ASTM C891.
2. Form continuous concrete channel and benches between inlets and outlets.
3. Install top of frames and covers flush with adjacent paved surfaces.
a. Install top of frame flush with adjacent landscaped surfaces.

F. Install cleanouts and extension from storm drainage pipe to cleanout at grade at locations indicated on Drawings.
1. Set cleanout frame and cover in concrete pad, 18 inches by 18 inches by 12 inches deep except at where location is in concrete paving.
2. Set top of cleanout 1 inch above surrounding earth grade.
3. Set top of cleanout flush with surrounding pavement.

G. Tap Connections:
1. Make connections to existing storm sewer and underground structures to comply with requirements of this Section, as indicated on Drawings.

H. Install underground warning tape continuous buried 6 inches below finish grade, above pipe line.
1. Coordinate with Section 312000.

I. Backfilling: Comply with requirements of Section 312000.

3.3 PROTECTION

A. Protect installed sewage system from damage of displacement until backfilling operation is complete.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 33 71 19 – UNDERGROUND DUCT BANKS

1. GENERAL

1.1 The scope of this document is to provide instruction for installation and testing of electric power duct banks and telecommunication systems duct banks installed on the University of Missouri campus.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

2. MATERIALS

2.1 Underground Ducts

A. Conduit

1. Underground concrete encased conduit duct banks shall consist of Type DB-60 or Schedule 40 polyvinyl chloride (PVC) conduit rated for 90°C cable and meeting NEMA Standard TC-6 and ASTM F-512 for underground applications.
2. Unless otherwise noted on the drawings, the standard conduit size shall be 3”, 4” or 5” for all conduits.
3. Conduits shall have long rigid steel metallic or fiberglass sweep elbows, 48” minimum radius for horizontal bends and 36” radius for vertical bends. Conduit elbows shall be PVC coated with taped ends.
4. All joints shall have watertight seals.
5. Conduit End Bells

    a. Conduit end bells for PVC conduit shall be polyvinyl chloride (PVC).
    b. Conduit end bells for rigid galvanized steel conduit shall be hot-dipped galvanized malleable iron or steel, threaded to the end of the rigid galvanized steel conduit.

B. Concrete

1. Color Additive

    a. The concrete for all concrete encased conduit **electric power** duct banks shall have a medium red color additive. The color additive shall have a minimum concentration per manufacturer’s recommendation per yard of concrete and shall be mixed throughout the entire duct bank concrete.
    b. Concrete for concrete encased conduit **telecommunications** duct banks shall have no color additive.

2. Admixtures

a. Air-entraining mixture shall be used for all exterior concrete and shall conform to ASTM C260. The total calculated air content by volume as determined by ASTM C231 shall be as follows:

Maximum Coarse Aggregate Size	Total Air Content, % Includes Trapped Air
3/4"	3-8
1"	4-6

b. Water reducing admixture shall be used to reduce the total water requirements. Water reducing admixture shall meet the requirements of ASTM C494, Type A.
c. Calcium chloride or accelerating admixtures containing calcium chloride shall not be used.
d. Proportioning

1) Concrete slump at the time of placement as determined by ASTM C13 shall be 3" to 4". Tolerance up to 1" above maximum will be allowed providing average of batches tested does not exceed maximum.
2) The minimum 28 day concrete compressive strength for concrete shall be 4,000 psi (6 sacks/cu. yd. minimum).

e. Reinforcement

1) All concrete encased electric conduit duct banks shall contain steel reinforcing throughout the entire length as indicated on Duct Bank Detail drawing. The minimum size of reinforcing steel shall be size No. 4.

f. Backfill

1) Backfill material shall be clean soil fill or ¾" minus waste rock fill. No concrete or large rocks are to be used. Backfill shall be compacted as installed.

3. ACCESSORIES

3.1 The pull string installed in spare electrical power conduits shall have a minimum of 240 lbs. tensile strength and shall be rot and mildew resistant. Pull string shall be made of nylon or polypropylene. Pull string shall have permanently printed sequential measurements at one foot increments.

3.2 All conduits for telecommunication duct banks shall be equipped with a minimum 1,500 lb strength mule-tape pull line. Pull line shall have permanently printed sequential measurements at one foot increments.

3.3 Use plastic plugs with wick for drainage to seal spare conduits in manholes.

A. Underground Warning Tape

1. Warning tape shall be fabricated from polyethylene film, and shall be 6 inches wide and not less than 3.5 mils thick.
2. For all electric power duct banks, warning tape shall be high visibility red in color and imprinted at frequent intervals with black letters having the following wording: CAUTION BURIED ELECTRICAL LINE BELOW
3. For all telecommunications duct banks, warning tape shall be high visibility orange in color and imprinted at frequent intervals with black letters having the following wording: CAUTION BURIED COMMUNICATIONS LINE BELOW

4. INSTALLATION

4.1 Conduit and Duct Banks

A. Conduit shall be adequately and properly supported on solid earth, or other indicated means, throughout the entire length of the run. All conduits shall be laid straight and true.

B. Verify routing locations of conduit prior to rough-in.

C. Couplings for conduits in a group shall be staggered at least six (6) inches.

D. Underground conduit duct banks shall be installed a minimum of 36” below finished grade to the top surface of the duct bank.

E. Underground conduit duct banks shall be at least 12 inches away from all other underground utilities; gas, water, electric, telephone, communications, etc., and at least 36 inches away from steam pipe lines and steam tunnels, trenches, or manholes.

F. Conduits shall be installed with a minimum slope of ½% toward manholes or other drainage points.

G. Intermediate and base spacers shall be used to obtain uniform separation and alignment during the installation of the concrete for concrete encased duct banks. Maximum intervals between spacers shall be 8 feet.

H. Concrete encased conduit duct bank penetrations into manholes shall continue completely through the wall of the manhole and shall use one large hole rather than several smaller holes. If this method is not practical, the concrete may stop outside the manhole but must be pinned to the manhole with steel pins to prevent any differential settlement.

I. Conduit end bells shall be installed at all conduit terminations in each manhole.

(1) Conduit end bells for PVC conduit shall be cast in place in the concrete wall of the manhole and glued to each end of each Type DB PVC conduit.

(2) Conduit end bells for rigid galvanized steel conduit shall be cast in place in the concrete wall of the manhole 3" between conduits and on outside including bottom.

4.2 Concrete

A. All duct banks used for 13.8Kv, 480/277V, or 208/120V systems shall be encased in **red** concrete.

B. All duct banks used for telecommunications systems shall be encased in **undyed** concrete.

C. Placing, Curing, and Backfill

1. Precautions shall be used to prevent ducts from floating.
2. Concrete shall be placed with the aid of a mechanical vibrator.
3. Curing shall be continued for at least 7 days in the case of all concrete except high-early-strength concrete for which the period shall be at least 3 days. Excavations should not be backfilled until concrete has cured.
4. In no cases shall ductbank sidewall thickness exceed 12" from side of duct.

D. Reinforcement

1. The reinforcing steel shall be installed longitudinally, at each corner of the duct bank (in cross section) and along the top and bottom and sides at a maximum of 12 inches on center. All reinforcing steel (including bottom) shall have a minimum concrete cover of 1-1/2 inches. Reinforcing shall be installed latitudinal, as needed, to hold the longitudinal steel in place during the placement of the concrete but no more than 48" apart. Refer to the Ductbank Details in the plans.

4.3 Accessories

A. All empty or "spare" conduits shall have a nylon or polypropylene pull string installed for future use. Leave not less than 2 feet of slack at each end of pull string.

B. Seal the ends of all conduits at manhole penetrations. Seal water tight with plastic plugs with wick for drainage. Conduit pull string shall penetrate through seal.

4.4 Underground Warning Tape

A. The location of all underground conduit duct banks shall be marked by burying one or more warning tapes below grade in the backfill. The warning tape shall be placed 18 inches above the top of the conduit(s) or duct bank and shall be parallel along the full length of the run.

B. If the widths of the conduits or duct bank is wider than 2 feet, two or more warning tapes shall be used, all in the same plane, spacing the tapes no more than 12 inches apart horizontally across the top width of the conduits or duct bank and equally spacing the tapes in from each longitudinal outer edge of the buried conduits or duct bank

5. TESTING

A. All duct banks shall be inspected by system owner prior to concrete placement.

B. Upon completion of the installation of each duct bank, demonstrate that all conduits are clear of obstructions by pulling a mandrel ½ inch smaller than the nominal size of the conduit through the entire length of each conduit.

6. COMMISSIONING

6.1 Electric Underground Duct

A. All soil and debris shall be removed from manholes and equipment pads where ductbanks terminate.

B. Verify all pull strings and caps are installed

END OF SECTION 33 17 19

THIS PAGE INTENTIONALLY LEFT BLANK