TABLE OF CONTENTS

END OF SECTION

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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
c/o Campus Facilities, Planning Design & Construction, Room L100 (Front Reception Desk),
General Services Building, University of Missouri, Columbia MO 65211

1. Bidder, in compliance with invitation for bids for construction work in accordance with Drawings and Specifications prepared by HELLMUTH, OBATA & KASSABAUM, INC., entitled "New Indoor Practice Facility", project number CP210981, dated July 13, 2021 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: New Indoor Practice Facility

The Bidder agrees to furnish all labor, materials, tools, and equipment required to __; all as indicated on the Drawings and described in these Specifications for sum of:

_____
_____DOLLARS ($_____).

b. Additive Alternate Bids:

Alternate #1: Stone Base
Alternate #2: Expanded Parking Lot G, Includes Grading for Broadcast Relocation
Alternate #3: Broadcast Utility Relocation

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: Stone Base
All for sum of:

_____
_____DOLLARS ($_____).

(2) Additive Alternate No. 2: Expanded Parking Lot G, Includes Grading for Broadcast Relocation
All for sum of:

_____
_____DOLLARS ($_____).

(3) Additive Alternate No. 3: Broadcast Utility Relocation
All for sum of:

_____
_____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.

FILL IN ONLY ONE PRICE PER LINE

(6) Removal of unsuitable material below subgrade for building and site, proper disposal of unsuitable material, and replacement with satisfactory material when directed by the Geotechnical Engineer. NOTE: All excavation above subgrade is unclassified and shall be included in base bid.

Base Bid quantity = 100 cu. yd. $_____/cu. yd.

(7) Bulk rock excavation below exposed subgrade for building and site, proper disposal of excavated rock, and replacement with satisfactory material. NOTE: All excavation above subgrade is unclassified and shall be

included in base bid.

Base Bid quantity = 100 cu. yd. $_____/cu. yd.

(8) Removal of unsuitable material below subgrade of footings, utility trenches and utility tunnels, proper disposal of unsuitable material, and replacement with satisfactory materials when directed by the Geotechnical Engineer. NOTE: All excavation above subgrade is unclassified and shall be included in base bid.

Base Bid quantity = 100 cu. yd. $_____/cu. yd.

(9) Rock excavation below the subgrade of footings, utility trenches, and utility tunnels, proper disposal of excavated rock, and replacement with satisfactory materials. NOTE: All excavation above subgrade is unclassified and shall be included in base bid.

Base Bid quantity = 100 cu. yd. $_____/cu. yd.

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 achieve Substantial Completion ~~by October 31, 2022~~ **not later than June 30, 2023**. 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. Not used.

d. Special scheduling requirements: As indicated in 1.E Special Conditions.

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		
Electrical		
Earthwork		

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 ninety (90) 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 an irrevocable letter of credit, 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	
Mailing Address	
City, State, Zip	
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

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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 July 13, 2021.

b. Architect
Hellmuth, Obata, Kassabaum, Inc.
300 W. 22nd Street
Kansas City, Missouri 64108
Telephone: (816) 472-3360

c. Mechanical, Electrical, and A/V Engineer
Henderson Engineers
1801 Main Street, Suite 300
Kansas City, Missouri 64108
Telephone: (816) 663-8700

d. Structural Engineer
Thornton Tomasetti
2323 Grand Blvd., Suite 900
Kansas City, Missouri 64108
Telephone: 816.221.7771

e. Civil Engineer
SK Design Group, Inc.
4600 College Boulevard, Suite 100
Overland Park, KS 662211
Telephone: 913.451.1818

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

2. SPECIAL SCHEDULING REQUIREMENTS

a. Special scheduling requirements supplemental to the bid form

(1) ~~Contractor shall perform all work in the designated area between 11/22/2021 and 11/30/2022.~~ **The site will be available to the Contractor**

after the last home game of the 2021 football season. Substantial Completion shall be as indicated on the bid form.

(2) **Make parking lots fully accessible for all football seasons on game days.**~~On-site mobilization may commence November 21, 2021, after the last 2021 home game scheduled for November 20th, 2021.~~

~~(3)~~**(1)** ~~Lot C and Lot G parking lots shall be complete and clear of all construction staging, including equipment and trailers, and turned over to the Owner for intended use by September 16, 2022, in time for the first 2022 home football game scheduled for September 17th, 2022.~~

~~(4)~~**(3)** Throughout construction, Contractor shall schedule and coordinate use of existing service drive between lot C and lot G with Owners representative, and shall maintain a safe and clear pathway for both pedestrian foot traffic and emergency vehicular traffic throughout construction of the project.

~~(5)~~**(4)** Contractor shall schedule and coordinate with Owner Representative approval, all work for the new water line to be constructed in parking lot SG7, (student parking on west side of Memorial Stadium,) during a break in the academic calendar.

~~(6)~~**(5)** Contractor shall maintain clear and safe access to pedestrian bridge across Providence road at all times. If any work will necessarily disrupt access to either the pedestrian bridge or the service road, scheduling is to be coordinated with the owner representative with at least 72 hours advance notice.

~~(7)~~**(6)** Mass excavation blasting schedule shall schedule the first blast to occur on a Monday afternoon for a specific time identified between 2:00 and 4:00 PM. This shall be coordinated with MU Research Reactor (MURR) staff, to allow MURR staff to gage the potential impact of a blast on reactor operation.

~~(8)~~**(7)** Contractor shall coordinate scheduling of video board, building signage, irrigation and plantings, specific telecom scopes, or other work provided and/or installed by Owner or separately contracted Owner Vendors.

~~(9)~~**(8)** Reference Drawing C071 Site Staging and Laydown Plan.

(9) For the PEMB, the owner and consultant are committed to expedite the submittal review via weekly work sessions per an established submittal schedule. The contractor is to provide a PEMB submittal schedule within 7 days of notice to proceed.

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 Indoor Practice Facility located south of Memorial Stadium on existing Parking Lot C. The new facility includes a full-size football field within a pre-engineered metal building superstructure. Additional program elements include restrooms, exam spaces, storage and support for this facility within the building. The site allows access to two mezzanines. One mezzanine is located at the Lot C elevation which provides amenities such as a lobby, restrooms, and a large viewing platform. An intermediate mezzanine can be accessed from Level 2 to be used as a recruit viewing area and camera platform. This project site predominately occupies the existing Parking Lot C, with overlap into the lower Parking Lot G.

(2) Demolition shall consist of site related demolition as shown in the civil documents.

(3) Architectural work shall consist of a new indoor practice facility with a brick, glass, translucent panel, and insulated metal panel façade. The roof over the IPF will be a standing seam metal roof. The roof over the program space will be a PVC roof.

(4) Structural work shall consist of a pre-engineered metal building (PEMB) for the practice field area. The additional program space will be a structural steel framed building. The two elevated floor levels will consist of slab on metal deck composite steel beams and girders supported by steel columns.

(5) Mechanical work shall consist of packaged HVAC equipment for mechanical heating and cooling. Cooling will be provided by Direct Expansion (DX) systems utilizing condensing units with refrigerant compressors. Heating will be provided by natural gas heat exchangers.

(6) Electrical work shall consist of power for convenience and equipment receptacles, HVAC and plumbing equipment, interior and exterior lighting, elevators, and miscellaneous loads.

4. LOCATION

Work shall be performed under this Contract on campus of the University of Missouri –

Columbia.

5. NUMBER OF CONSTRUCTION DOCUMENTS

a. NOT USED

b. NOT USED

c. NOT USED

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 two (2) 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, steam, sewer, and nitrogen. 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 Civil Drawings and as directed by the Owner's Representative.

b. Parking:

(1) Contractors' service vehicle parking shall remain within designated staging limits.

(2) Parking of personal vehicles within project access/lay down/staging areas is prohibited. Violation of this requirement may result in ticketing and/or towing at the vehicle owner's expense and suspension of progress payments.

(3) 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.

(4) Sidewalk(s) and Hardscape – Parking/driving on hardscapes is strictly prohibited unless specifically directed by the Owner's Representative through the MU sidewalk permitting process. Restricted use permits will be limited to activities that are constrained by an absolute need to access from a sidewalk. Such activities shall be considered the exception and not the norm. Adequate signage, fencing and alternate routes must be provided in the immediate and adjacent areas.

(5) Free parking for contractor employees is available in the Ashland Road Contractor lot on an as available basis. This space is for use by contractor employees for parking their personal vehicles only and is not to be used for

staging or storage.

(6) Vendor Permits may be purchased by contractor management personnel on an as available basis by contacting the Parking and Transportation office in the General Services Building. These permits will allow contractor management personnel to park in various University lots while conducting business on University construction projects.

(7) Temporary University parking permits may be purchased by contractor employees for use with their personal vehicles on an as available basis by contacting the Parking and Transportation office in the General Services Building.

(8) Conley Avenue between Missouri Avenue and University Avenue and Hitt Street between University Avenue and the Memorial Union are designated for pedestrian use only during the work week between the hours of 8:15 AM and 3:45 PM. Unless otherwise indicated in the contract documents, this area is strictly off limits to vehicular traffic without authorization from the Owner's Representative.

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.

d. Utilities: Drinking water, water required to carry on work, and 120 volt electrical power required for small tool operation may be obtained without cost to the Contractor from existing utilities at locations designated by the Owner's Representative. Provisions for obtaining power, including temporary extensions, shall be furnished and maintained by the Contractor. Upon completion of work such extensions shall be removed and any damage caused by use of such extensions shall be repaired to satisfaction of the Owner's Representative, at no cost to the Owner.

e. 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.

f. 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.

g. 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.

h. 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.

i. 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 within the project limits:

(1) Storm sewer manholes and structures
(2) Sanitary sewer manholes and structures
(3) Electrical manholes and structures

(4) Telecom manholes and structures
(5) Utility trenches
(6) Excavations
(7) Any other confined space meeting the requirements of OSHA 1926

The hazards or potential hazards in each "permit required confined space" or the reason it is a "permit required confined space":

(1) Contains or has a potential to contain a hazardous atmosphere;
(2) Contains a material that has the potential for engulfing an entrant;
(3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller crosssection; or
(4) Contains any other recognized serious safety or health hazard.

Any precautions that the owner or previous contractors have implemented for the protection of employees in the "permit required controlled space":

(1) Contractor shall comply with the requirements of OSHA 1926.1204.

The above list of known confined spaces within the project limits may not be a complete listing. Each contractor shall survey the project to identify all confined spaces. It is incumbent upon each contractor to list all "permit required spaces".

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" after evaluation by a competent person; 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.

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) Fence screening fabric shall be used on all perimeter fencing. Fabric shall be black in color, full height of the project fence, securely attached and properly maintained throughout the duration of the project.

(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) Contractor shall take sequential steps in the following order, to protect trees shown to remain/be protected or be saved.

1. Mark designated drip line of treed area or trees to remain/be protected.

2. Trim branches as described herein and as required to minimize potential damage.

3. Mulch as described herein.

4. Install protective fencing and construction fencing where indicated on the drawings.

(b) Trees and shrubs within work area designated to remain, or trees beyond construction limits designated to be saved, 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. Trees located in areas beyond the construction limits and that branch beyond the designated drip line shall be trimmed to minimize potential damage.

(c) 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) 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.

(3) 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.

(4) Trimming of limbs necessary to minimize potential damage or provide clearance for work shall be done by approved, trained tree maintenance subcontractor and coordinated with the Owner’s representative prior to trimming. Limbs shall be cut off cleanly and cut surfaces treated according to established horticultural standards.

(5) A minimum 30 foot wide swath of coarse (minimum 6" deep) coarse mulch shall be installed on the ground in the wooded areas along the length and immediately beyond the designated tree drip line and/or construction limits, which ever is closest to the work. Install mulch immediately before installation of construction fencing.

10. SUBSTITUTIONS and EQUALS

a. Substitutions are defined in General Conditions article 3.11.8 for and Equals are defined 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 of any item described in the Contract Documents will be allowed only prior to the receipt of bids provided that a request for approval has been 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.

d. No substitutions and/or equal will be allowed for the following items:

Item	Specification Section
Lock Cylinders	08 71 00
Water Meters	22 11 16
Fire Hydrants	33 11 00

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

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

a. Owner furnished products: Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products and making building services connections.

(1) Toilet Accessories.

(2) Turf.

(3) Monitors.

(4) LED Video Boards.

(5) Fire Alarm.

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 No Dollar Limit Guarantee which shall be manually signed by an authorized representative of Manufacturer of each proposed roofing system. Certifications 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. Standard warranty agreement(s) shall be of the duration specified in Division 7.

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.

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:

(a) MINIMUM QUALIFICATIONS

(i) The schedule for the project is aggressive and requires a contractor with a successful track record of managing projects with average monthly expenditures of more than $25-million

(ii) Successful completion of one project of similar type and scope.

(iii) Successful completion of at least three projects of $25-million or greater value. Submit references for the three most recent projects over $25-million in value.

(iv) Electrical Contractor must have extensive experience installing 13.8-kV equipment and cable. Applicable for High Voltage work.

(v) 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

a. The Commercial General Liability policy or policies specified in Article 11 shall provide coverage for special hazards, where they exist, such as, but not limited to, the operation of material hoist, blasting or other use of explosives, and damage to underground property.

(1) Reference: General Conditions Article 11.2.1 Commercial General Liability.

Delete in the first sentence of 11.2.1: "$2,000,000 per occurrence, $5,000,000 in general aggregate, $5,000,000 products and completed operations aggregate and $1,000,000 personal injury and advertising injury"

and insert: "$2,000,000 per occurrence, $25,000,000 in general aggregate, $25,000,000 products and completed operations aggregate and $1,000,000 personal injury and advertising injury"

19. PROJECT SCHEDULING

The project scheduling specification for the project are included immediately after the Special Conditions. For this project the Contractor shall meet the following scheduling requirements.

Option 1: Contractor Schedule – Contractor is responsible for the schedule and must comply with the Owner's requirements. 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. NOT USED

22. NOT USED

23. BUILDING SYSTEM COMMISSIONING AND QUALITY ASSURANCE

a. Contractor shall provide all personnel and equipment required to complete the commissioning/quality assurance activities referenced in the Commissioning Plan/Quality Assurance Log. The requirements of the Quality Assurance Log 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 commissioning/quality assurance coordinator. The commissioning/quality assurance coordinator is responsible for planning, scheduling, coordinating, conducting and verifying all commissioning/quality assurance activities required by the Quality Assurance Log and ensuring all building systems are complete, operable and ready for use by the Owner. At a minimum, building ventilation systems, hot water generation systems, hydronic distribution systems, power distributions systems and fire detection and alarm and building envelope systems, as applicable.

c. The owner has hired a third-party Commissioning Agent, Braun Intertec for building envelope and Doyle Field Services for MEP, for this project. The Contractor shall participate in this Commissioning process as outlines in the Building System Commissioning requirements included in section 1.E.7 Commissioning Plan, 019191, 019191.2, and 230800 of this project manual.

d. The Contractor shall provide all personnel and equipment required to complete the quality assurance/commissioning activities and reporting, and coordinate with

Owner as noted in the Quality Assurance Log and Commissioning Plan. The requirements of the Quality Assurance Log and Commissioning Plan shall be completed in their entirety before substantial completion and submitted as referenced in the Closeout Log.

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. 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 contractor shall utilize the Owner's secure information sharing system for submittals, construction payment process, change orders,

RFI's/ASI's, O&M manuals and all other project manual requirements as directed by the Owner's Representative. Field staff are also required to utilize this software as directed by the Owner's Representative.

d. The Contractor shall provide at least two (2) job site FM handheld communication radios (walkie-talkies) for use by the on-site superintendent and the Owner's Representative or the Contractor shall provide his 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 (for projects without a Division 02 specification)

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: [for MU] 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.

32. DELEGATED DESIGN SUBMITTALS

DELEGATED DESIGN SUBMITTALS
a. FIRE SPRINKLER
b. FIRE ALARM
c. STRUCTURAL STEEL CONNECTIONS
d. PRE-ENGINEERED METAL BUILDING
e. METAL STAIRS
f. GUARD RAILINGS
g. FALL ~~ARREST~~ **RESTRAINT** SYSTEMS *Reviewed For Loads Imposed to Structure Only*
h. COLD FORMED METAL FRAMING
i. MEP ANCHORAGE
j. OVERHAD COILING DOORS AND FRAMES
k. EXTERIOR CLADDING
l. *NOTE: ANY ADDITIONAL DELEGATED DESIGN ITEMS NOTED IN THE DOCUMENTS SHOULD BE ADDED TO THE ABOVE LIST*

END OF SECTION

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SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SCOPE

Provide all labor, materials, equipment, services and transportation required to complete all concrete work as shown on Drawings, as specified herein, and as required by the job conditions. This Specification is not intended to address the particular requirements of Architectural Concrete.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

Submittals	Division 1
Quality Control	Division 1
Quality Assurance: Structural Testing and Inspection	Section 014500
Concrete Formwork	Section 031000
Concrete Reinforcement and Embedded Assemblies	Section 032000
Thermal and Moisture Protection	Division 7

1.3 CODES AND STANDARDS

A. Building Code: Concrete work shall conform to the requirements of the Building Code identified on the Structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the standards referenced below and on the Drawings.

B. Standards:

1. ACI 117 – Standard Specifications for Tolerances for Concrete Construction and Materials except as modified by more stringent requirements in the Project Specifications and/or Drawings.

2. ACI 237 – Self Consolidating Concrete.

3. ACI 301 – Specifications for Structural Concrete.

4. ACI 318 – Building Code Requirements for Structural Concrete and Commentary.

5. American Concrete Institute “Manual of Concrete Practice”, various committee reports as referenced herein.

6. American Society for Testing and Materials "ASTM Standards in Building Codes", various standards as referenced herein.

7. AASHTO T318 – Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.

C. Definitions:

1. The term “Contract Documents” in this Specification is defined as the design Drawings and the specifications.

2. The term “SER” in this Specification is defined as the Structural Engineer of Record for the structure in its final condition.

3. The term “Design Professionals” in this Specification is defined as the Owner’s Architect and SER.

4. The term “Contractor” in this Specification is defined to include any of the following: General Contractor and their sub-contractors, Construction Manager, Concrete Contractor and their sub-contractors.

5. The term “Testing Agency” in this Specification is defined as an independent testing and inspection service engaged by the Owner for quality assurance testing and inspection of structural construction in accordance with applicable building code provisions and any additional activities listed in the Contract Documents.

6. The terms “for record” and “submit for record” in this Specification are defined as Contractor submittals that do not require a response from the Design Professionals.

7. The term “Working Days” in this Specification is defined as Monday through Friday, excluding federal or state holidays.

8. The term “Delegated Design” in this Specification is defined as a scope of work that meets performance and design criteria established in the Contract Documents and is to be completed by the Contractor’s licensed engineer.

1.4 CONTRACTOR QUALIFICATIONS

A. The work of this section shall be performed by a company specializing in the type of concrete work required for this Project, with a minimum of 10 years of documented successful experience and shall be performed by skilled workmen thoroughly experienced in the necessary crafts.

B. Contractor’s testing agency services: Required as specified in Division 1, and herein.

1.5 SUBMITTALS

A. Required Submittals - Where the SUBMITTALS section of this Specification is in conflict with Division 1 Submittals, the more stringent requirements for the Contractor apply. Required submittal items are listed here; see below for detailed requirements. Do not submit items not requested. Reproduction of structural drawings for shop drawings is not permitted. **Building Information Models for contractor’s use may be provided as mutually agreed upon by Design Professionals.**

a) Submittal Schedule

b) Mix Designs

c) Concrete Travel Times to the Project Site

d) Hot and Cold Weather Procedures

e) Product Data

f) Concrete Joint Locations

g) Comprehensive Layout Drawings

h) Preconstruction Survey

i) Survey of Flat Plate or Flat Slab Concrete Floors during construction

j) FF/FL Testing

k) Structural Repairs

l) Patching Defective Concrete Finishes

m) Conduit and Pipes Embedded in Concrete

n) Hazardous Materials Notification

o) LEED Submittals

1. **Submittal Schedule**: The contractor shall submit for action a schedule at least twenty (20) working days prior to commencing submittals.

   a. This schedule shall include a list, in order of date to be submitted, of all drawings and other required submittal items scheduled to be submitted. The schedule shall list the proposed submittals for each week, as well as their formats. Once shop drawing submissions have commenced any modification or addition to this schedule must be submitted for action at least twenty (20) working days before the modification or addition is proposed to take place.

   b. If at any time the total number of shop drawings received in any one week period exceeds the amount in the approved schedule by more than 10% for that week, the Design Professionals have the right to add two days to the average turnaround time for each 20% increment in excess of the scheduled quantity for that week's submissions. For example if the weekly total exceeds the schedule by 10% to 20%, two days may be added; if it is exceeded by 21% to 40%, four days may be added. The return dates for subsequent submittals may be extended based on the additional review time stated above.

   c. For the purposes of developing a schedule, assume the following review rate, Shop drawings – 10 full size sheets per week.

2. **Mix Designs**: Submit for action concrete mix designs for each type and strength of concrete required for this Project at least thirty (30) days before placing concrete.

a. Mix designs shall be prepared or reviewed by an approved independent testing agency retained by the Contractor in accordance with requirements of ACI 301 and ACI 318 and shall be coordinated with design requirements and Contract Documents.

b. Before submitting to Testing Agency, submit complete mix design data for each separate mix to be used on the Project in a single submittal.

c. Provide a completed “Concrete Mix Design Submittal Form” (attached to the end of this Specification Section) for each proposed concrete mix.

d. Mix materials shall be from the same production facility that will be used for this Project.

e. Mix Design data shall include but not be limited to the following:

1) Locations on the Project where each mix design is to be used corresponding to Structural General Notes on the Drawings.

2) Design Compressive Strength: As indicated on the Drawings.

3) Proportions: ACI 301 and ACI 318.

4) Gradation and quality of each type of ingredient including fresh (wet) unit weight, aggregates sieve analysis.

5) Water/cementitious material ratio.

6) Evaluation and classification fly ash in accordance with ASTM D 5759.

7) Report of chemical analysis of fly ash in accordance with ASTM C 618.

8) Classification of slag cement in accordance with ASTM C 989.

9) Slump: ASTM C 143.

10) Air content of freshly mixed concrete by the pressure method, ASTM C 231, or the volumetric method, ASTM C 173.

11) Density of Concrete: ASTM C 138.

12) Design strength at 28, 56 or 90 days, as indicated on Contract Documents: ASTM C 39.

a) Document strength based on basis of previous field experience or trial mixtures per ACI 301. Proportioning by water-cement ratio alone, with no test results per the trial mixtures procedure is not permitted.

b) Submit strength test records, mix design materials, conditions, and proportions for concrete used for record of tests, standard deviation calculation, and determination of required average compressive strength. Test records to support proposed mixtures shall be no more

than 24 months old and use current cement aggregate sources. Test records to establish standard deviation may be older if necessary to have the required number of samples.

c) If early concrete strengths are required, Contractor shall submit trial mixture results as required.

13) Manufacturer's product data for each type of admixture.

14) Manufacturer's certification that all admixtures used are compatible with each other.

15) All information indicating compliance with Contract Documents including method of placement and method of curing.

16) Normalweight Concrete: Density per ASTM C 138. Design the mix to produce the strength, modulus of elasticity and density as indicated on the Contract Documents.

17) Lightweight Concrete: Density per ASTM C 138. Design the mix to produce the strength, modulus of elasticity and density as indicated on the Contract Documents.

a) Where lightweight concrete members are used, provide split cylinder strength factor, fct, as indicated.

18) Certification from a qualified testing agency indicating absence of potential for deleterious expansion of concrete due to alkali reactivity of the aggregate as determined by testing per ASTM C1260 in accordance with ASTM C 33. If potential for deleterious expansion exists, expansion reduction and mitigation measures per the guidelines of ASTM C1778 or US Army COE CRD-C662 shall be submitted for review by the SER.

3. Concrete Travel Times to the Project Site: Submit for record.

4. **Hot and Cold Weather Procedures**: Submit for record written procedures for placement of concrete in hot and cold weather conditions. Hot and Cold weather are as defined in the Concrete Placement section of this Specification.

5. **Product Data**: Submit for action product data clearly marked to indicate locations to be used and all technical information which specifies full compliance with this section and Contract Documents, including published application instructions, product characteristics, compatibility, and limitations for each of the following:

a. Bonding agents.

b. Curing compound and liquid sealer densifier. Submit for record to Design Professionals a written statement guaranteeing that the compound will not leave discoloration on concrete to be left exposed, or affect the bond for paint or other applied finishes. Include provision in written statement that in the event of failure of applied finishes to bond to membrane cured concrete, to remove the curing compound and leave suitable surfaces for bonding such finishes.

c. Absorptive covers and moisture retaining covers.

d. Vapor Retarder: See Division 7, Thermal and Moisture Protection.

e. Self-leveling concrete topping.

f. Grout: Submittal of grout by manufacturers not listed herein must be accompanied by independent certification of ASTM C 1107 compliance without modification of standard methods.

g. Other products proposed by Contractor.

6. **Concrete Joint Locations**: Submit for action plans indicating locations and details of construction joints, contraction joints, waterstops, sleeves, embedments, etc. that interact with the joints. Contractor to coordinate joint location with reinforcement shop drawings. Reinforcement shop drawings shall indicate additional reinforcement bars where required at construction joints.

   Joint locations for concrete slabs to receive a terrazzo or similar finish subject to reflective cracking must be coordinated with layout of finish drawings.

7. **Comprehensive Layout Drawings:** Submit for action comprehensive layout drawings (a single drawing per area/element):

   a. Drawings shall show openings in structural members, including floor slab, shear walls, columns and beams.

   b. Drawings shall consolidate the work of all trades and shall be coordinated by the Contractor.

   c. Drawings shall show concrete accessories and embedded items, including fabrication details of items to be placed (exclusive of reinforcement).

   d. Submit with or prior to reinforcement and formwork submittals for same element/area.

8. **Preconstruction Survey**: Submit for record. Where interface with existing construction occurs, before related shop drawings are prepared survey the existing construction and submit the survey prepared by a professional surveyor employed by the Contractor to the Design Professionals.

9. **Survey of Flat Plate or Flat Slab Concrete Floors during construction**: Submit for record. Survey requirements are described on Drawings. Based on survey results, SER may propose adjustments to formwork and camber.

10. **FF/FL Testing:** Submit for record. Testing Agency to test and report flatness (F_F), levelness (F_L) prior to shoring removal. For slabs that include camber, do not test for levelness (F_L). Perform F_F/F_L testing in accordance with ASTM E 1155 requirements.

11. **Structural Repairs**: Submit for action procedures, intended locations, and product information. Alterations to design shall be sealed and signed by a **Structural** Engineer licensed in the state where the project is located.

12. **Patching Defective Concrete Finishes**: Submit for action procedures, intended locations, and product information.

13. **Conduit and Pipes Embedded in Concrete:** Submit for action layout of embedded conduit and pipes.

14. **Hazardous Materials Notification**: Submit for record. In the event no product or material is available that does not contain hazardous materials as determined by the Owner, a "Material Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

15. LEED Submittals:

B. Submittal Process

1. Submittal of shop drawings and other submittals by the Contractor shall constitute Contractor's representation that the Contractor has verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar data with respect thereto and reviewed or coordinated each drawing with other Drawings and other trades. The Contractor shall place their shop drawing stamp on all submittals confirming the above.

2. Shop drawings: Submit in complete packages so that individual parts and the assembled unit may be reviewed together. This Specification Section and the applicable Drawings used in the development of the shop drawings shall be referenced on each shop drawing to facilitate checking.

3. The Contractor shall submit to the Design Professionals one (1) electronic copy for shop drawing review. The naming convention of each drawing must follow the submittal numbering system and include the submittal number, Specification number, revision number and drawing number in the prefix of the drawing name.

4. The Contractor shall allow at least **ten (10)** working days between receipt and release by the SER for the review of shop drawings and submittals.

5. All modifications or revisions to submittals and shop drawings must be clouded, with an appropriate revision number clearly indicated. The following shall automatically be considered cause for rejection of the modification or revision whether or not the drawing has been approved by the Design Professionals:

   a. Failure to specifically cloud modifications

   b. Unapproved revisions to previous submittals

   c. Unapproved departure from Contract Documents

6. Resubmittals: Completely address previous comments prior to resubmitting a drawing. Resubmit only those drawings that require resubmittal. Do not include new content not previously reviewed.

7. Resubmittals Compensation: The Contractor shall compensate the Design Professionals for submittals that must be reviewed more than twice due to Contractors' errors. The

Contractor shall compensate the Design Professionals at standard billing rates plus out-of-pocket expenses incurred at cost + 10%.

8. The Contractor shall deliver to the Design Professionals at the completion of the job two (2) copies of the electronic version of the final as-built shop drawings on a CD-ROM or other media acceptable to the Design Professionals.

C. SER Submittal Review

1. The Design Professionals' review and approval of shop drawings and other submittals shall be for general conformance with the design intent of the work and with the information given in the Contract Documents only and will not in any way relieve the Contractor or the Contractor's Engineer from:

   a. Conforming to the Contract Documents.

   b. Coordination with other trades.

   c. Responsibility for all required detailing and proper fitting of construction work.

   d. The necessity of furnishing material and workmanship required by Drawings and Specifications which may not be indicated on the shop drawings.

   e. Control or charge of construction means, methods, techniques, sequences or procedures, for safety precautions and programs in connection with the work.

2. TYPE 1 – Structural Submittal Review Stamp: For shop drawings for building elements designed by the SER, the responses on the shop drawing review stamp used by the SER require one of the following actions:

   a. APPROVED indicates that the SER has found that the information presented on the shop or erection drawing appears to conform to the requirements of the Contract Documents. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the Contract Documents.

   b. APPROVED AS NOTED indicates that the SER requires the shop or erection drawing to be corrected to reflect the notes and comments shown. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the notations shown on the shop drawings and the Contract Documents. Promptly resubmit the corrected shop or erection drawing for record.

   c. REVISE and RESUBMIT indicates that the SER requires resubmission of the shop or erection drawing after correction per notes and comments. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed until the Contractor has received a returned shop drawing marked Approved or Approved as Noted.

   d. NOT APPROVED indicates that the shop or erection drawing does not conform to the Contract Documents and must be extensively revised before re-submittal. None of the elements of work shown on the shop drawing shall be fabricated,

manufactured or constructed until the Contractor has received a returned shop drawing marked Approved or Approved as Noted.

3. TYPE 2 – Delegated Design Review Stamp: For submittals for building elements which are not designed by the SER but are delegated design items, or for items that do not form part of the completed structural system but impose loads on the structure, or for construction items or activities which have an effect on the final structure. The responses on the stamp used by the SER require one of the following actions:

   a. NO EXCEPTIONS indicates that the SER has found that the information presented on the submittal appears to conform to the requirements of the Contract Documents. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the Contract Documents.

   b. EXCEPTIONS NOTED indicates that the SER requires the submittal be corrected to reflect the notes and comments shown. Fabrication, manufacture or construction of the elements of work shown in the shop drawing may proceed, provided that work is in compliance with the notations shown on the shop drawings and the Contract Documents. Promptly resubmit the corrected document for record.

   c. REJECTED indicates that the SER requires resubmission of the submittal after correction per notes and comments. None of the elements of work shown on the shop drawing shall be fabricated, manufactured or constructed. Contractor to revise and resubmit until SER response of No Exceptions or Exceptions Noted is received.

D. Substitution Request

1. Requests for any departure from Contract Documents must be submitted in writing by the Contractor and accepted in writing by the Design Professionals, prior to receipt of submittals.

2. All substitutions must be requested using the structural substitution request form included at the end of this section. Acceptance using the structural substitution request form indicates acceptability of the structural concept only. Contractor must submit shop drawings reflecting accepted substitutions for review in accordance with this Specification. The structural substitution request form, even if accepted, does not constitute a change order.

3. Accepted substitutions or modifications shall be coordinated and incorporated in the work at the sole expense of the Contractor.

4. The acceptance by the Design Professionals of a specific and isolated request by the Contractor to deviate from these requirements does not constitute a waiving of that requirement for other elements of, or locations in the project, unless specifically addressed as such and permitted by the Design Professionals in writing.

5. Compensation for Additional Services: Should additional work by Design Professionals such as design, documentation, meetings and/or site visits be required which are necessitated for the review and/or incorporation of the Contractor-requested substitution, including indirect effects on other portions of the work, the Contractor is responsible for paying for additional work performed by the Design Professionals at the standard billing

rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.

6. Contractor is responsible for means and methods and any impacts on other portions of the work that may arise from this substitution.

E. Request for Information (RFI)

1. RFIs shall be submitted by the Contractor. RFIs submitted by other entities will be returned with no response.

2. Limit RFI to one subject.

3. Submit RFI immediately upon discovery of the need for interpretation or clarification of the Contract Documents. Submit RFI within timeframe so as not to delay the Construction Schedule while allowing the full response time described below.

4. The response time for answering an RFI depends on the category in which it is assigned.

a. Upon receipt by the SER, each RFI will be assigned to one of the following categories:

1) No cost clarification

2) Shown in Contract Documents

3) Change to be issued in future document revision

4) Previously answered

5) Information needs to be provided by others

6) Request for corrective field work

7) Request for substitution

b. RFIs in the first five categories listed above will be turned around by the SER on average of **five (5)** working days.

c. RFIs in the last two categories listed above will be immediately rejected and must be submitted as submittals or requests for substitution.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with General Conditions and Division 1.

B. Storage:

1. Store materials in accordance with ACI 304R.

2. Store cement in weather-tight buildings, bins or silos that will exclude moisture and contaminates.

3. Store admixtures to avoid contamination, evaporation, damage, and in accordance with manufacturer's temperature and other recommendations.

4. Keep packaged material in original containers with seals unbroken and labels intact until time of use.

C. Handling:

1. Handle fine and coarse aggregates as separate ingredients.

2. Arrange aggregate stockpiles to avoid excessive segregation, and prevent contamination with other materials or with other sizes of like aggregates.

3. Do not use frozen or partially frozen aggregates.

4. Allow sand to drain until it has reached relatively uniform moisture content before use.

5. Protect liquid admixtures from freezing and temperature changes that would adversely affect characteristics, and in accordance with manufacturer's recommendations.

1.7 PRE-CONCRETE CONFERENCE

A. At least 30 working days prior to the start of concrete construction, the Contractor shall hold a meeting to review the proposed concrete mix designs and to determine the procedures for producing proper concrete construction. The Contractor shall notify the Design Professionals of the meeting and require responsible representatives of every party who is concerned with the concrete Work to attend the conference, including but not limited to the following:

1. Contractor’s superintendent.

2. Testing Agency representative responsible for field quality control.

3. Concrete subcontractor.

4. Ready-mix concrete producer.

5. Admixture manufacturer(s).

6. Architect.

7. Structural Engineer.

B. Minutes of the meeting shall be recorded and distributed by the Contractor to all parties concerned within five working days of the meeting. One copy of the minutes shall also be furnished to the following:

1. Design Professionals.

2. Owner's Representative.

C. The minutes shall include a statement by the concrete contractor and admixture manufacturer(s) indicating that the proposed mix design and placing, finishing, and curing techniques can produce the concrete properties and quality required by these Specifications.

1.8 QUALITY ASSURANCE BY OWNER'S TESTING AGENCY

A. See Section 014500.

1.9 QUALITY CONTROL BY CONTRACTOR

A. The Contractor shall provide a program of quality control to ensure that the minimum standards specified herein are attained.

B. The Owner's general review during construction and activities of the Testing Agency are undertaken to inform the Owner of performance by the Contractor but shall in no way replace or augment the Contractor's quality control program or relieve the Contractor of total responsibility for quality control.

C. The Contractor shall immediately notify the Design Professionals of any deficiencies in the work which are departures from the Contract Documents. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. After proposed corrective action is accepted by the Design Professionals and Owner, the Contractor shall correct the deficiency at no cost to the Owner. Where the Contractor requests that the Design Professionals develop the corrective actions or review corrective actions developed by others, the Design Professional shall be compensated as outlined in the OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS section of this Specification.

D. Where SCC is used, the Ready Mix Producer shall have a Quality Control Representative on site during placements until mix consistency and stability is established.

1.10 OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS

A. Observations: The Design Professionals will observe the construction for general compliance with the provisions of the Contract Documents during various phases of construction.

B. Corrections by Design Professionals: See Part 3 - CORRECTIVE MEASURES section of this Specification.

1.11 PERMITS AND WARRANTY

A. Permits: The Contractor shall apply for, procure, renew, maintain, and pay for all permits required by City, State, or other governing authorities, necessary to execute work under this Contract. Contractor shall furnish copies of all permits to the Owner and Design Professionals.

B. Warranty: Comply with General Conditions, agreeing to repair or replace specified materials or work that has failed within the warranty period. Failures include but are not limited to the following:

1. Oily, waxy or loose residue which may interfere with the bonding or discoloration of various applied Architectural finish materials.

2. Discoloration of concrete surfaces scheduled to remain exposed as a finish.

3. Areas which show surface failure or defects.

4. Areas which puddle water.

5. Areas which are not properly prepared to receive Architectural finish materials. If necessary, the Contractor, at his own expense, shall have the Testing Agency perform appropriate tests for bond and discoloration.

6. Patches that become crazed, cracked or sound hollow when tapped.

7. Self-leveling concrete topping that has cracked, spalled and/or not performed in accordance with manufacturer's design criteria.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS AND PRODUCTION

A. Portland Cement:

1. ASTM C150, Type I or Type II

2. ASTM C150, Type III, High-early Strength Portland Cement may be used subject to review and approval of the SER. The specified 28-day concrete compressive strength shall occur within 7 days for concrete using Type III Portland Cement.

3. [ASTM C150, Type V

4. Provide the same brand of Portland Cement **produced in the United States** from a single source throughout the project, as required to meet Design Professionals' requirements.

5. Provide Portland Cement that is uniform in color.

B. Blended Hydraulic Cement:

1. ASTM C595, Type IL, Portland-Limestone Cement

2. ASTM C595, Type IS, Portland-Slag Cement

3. ASTM C595, Type IP, Portland-Pozzolan Cement

4. ASTM C595, Type IT, Ternary-Blended Cement

5. [ASTM C595, Type IT (MS) for Exposure Class S1

6. ASTM C595, Type IT (HS) for Exposure Class S2

7. ASTM C595, Type IT (HS) plus pozzolan or slag cement for Exposure Class S3]

C. Aggregates for Normalweight Concrete:

1. ASTM C 33

2. Fine Aggregate: Natural sand, or sand prepared from stone or gravel, clean, hard, durable, uncoated and free from silt, loam and clay.

3. Provide aggregates from a single source throughout the project for exposed concrete.

4. The acceptability of aggregates for the work will depend on proof that their potential alkali reactivity is not deleterious to the concrete.

5. Do not use fine or coarse aggregates that contain substances that cause spalling.

6. Maximum coarse aggregate size shall conform to the requirements as specified in ACI 301 but shall not exceed the following:

Size no. 57 (25mm max) for footings, drilled piers and caissons
Size no. 67 (20mm max) for all other locations
Size no. 467 or 457 for non-reinforced concrete at locations noted on Drawings.

7. Contractor shall furnish concrete with maximum 3/8" (10mm) aggregate at no additional cost to the Owner if areas of high reinforcement density require it for placement and consolidation.

D. Aggregates for Lightweight Concrete:

1. ASTM C 330: Except aggregates prepared by processing natural materials, such as pumice, scoria, or tuff.

2. Classification of Aggregates: As required to meet Design Professional’s requirements.

3. Provide aggregates from a single source throughout the project for exposed concrete.

4. Aggregate shall contain the minimum absorbed moisture content recommended by the manufacturer for the project prior to batching.

5. Maximum coarse aggregate size shall conform to the requirements as specified in ACI 301 but shall not exceed ¾” (20mm)

E. Water: ASTM C 1602. Clean, and free from injurious amounts of oil, acids, alkali, salts, organic material, or other deleterious materials.

F. Supplementary Cementitious Material

1. Fly Ash: ASTM C 618, Class C or Class F.

2. Slag Cement: ASTM C 989.

3. Silica Fume (Microsilica): ASTM C1240.

    a. Acceptable Products:

        1) Force 10,000 D by GCP Applied Technologies, Inc.

        2) Eucon MSA by Euclid Chemical Company

        3) MasterLife SF 100 by BASF Coroporation

        4) Sikacrete 950 DP by Sika Corporation

4. Metakaolin: ASTM C 618, Class N.

    a. Acceptable Products:

        1) MetaMax by BASF Kaolin, part of BASF Corporation

        2) HRMK 100 by GCP Applied Technologies, Inc.

        3) Sikacrete M-100 by Sika Corporation

5. For concrete assigned to Exposure Classes F1 and F2, as defined in ACI 318, there is no limit to the maximum amount of supplementary cementitious materials included in the mix as a percentage of total cementitious materials by mass.

6. For concrete assigned to Exposure Class F3 as defined in ACI 318, limits to the maximum amount of supplementary cementitious materials included in the mix as a percentage of total cementitious materials by mass are as follows:

    a. Fly ash or other pozzolans conforming to ASTM C618 = 25%

    b. Slag cement = 50%

    c. Silica fume = 10%

    d. Total of fly ash or other pozzolans and silica fume = 35%

    e. Total of fly ash or other pozzolans, slag cement and silica fume = 50%

    f. The maximum percentage limits listed above shall include the supplementary cementitious materials used in the manufacture of ASTM C595 blended cements.

7. The fly ash or natural pozzolan supplier shall have an effective quality control program in place to guard against contamination of the fly ash and assure compliance with Specifications.

8. Supplementary Cementitious Materials shall be from one source throughout the project. Substitution of sources will be acceptable only if testing of concrete mixes containing the substituted material show similar test results and if the color of concrete produced with the substituted material matches the color of previously poured concrete to the satisfaction of the Architect.

G. Ready Mixed Concrete:

1. Shall be batch-mixed and transported in accordance with ASTM C 94.

H. Self-Consolidating Concrete:

1. Produce in accordance with ACI 237R.

2. Perform the following tests and provide report prior to submitting mix design:

a. Resistance to Segregation: Achieve a maximum static segregation percentage of 15% when tested according to ASTM C 1610 with a VSI index of 1 maximum.

b. Slump Flow: ASTM C 1611 within a range **of [20"-30" (500mm–750mm)]**.

c. Passing Ability: ASTM C 1621 with a maximum difference of 2" (50mm) between testing with and without the J-Ring.

2.2 CONCRETE MIX DESIGN

A. Concrete Strength:

1. Shall be as indicated on the Structural Drawings

2. Where concrete strength is not indicated on the drawings, the minimum concrete strength for exposure classes as defined in ACI 318 are as follows:

a. F0, S0, W0, C0, C1 = 2500 psi

b. F1 = 3500 psi

c. S1, W1 = 4000 psi

d. F2, S2, S3, = 4500 psi

e. F3, C2 = 5000 psi

B. Concrete Density (Unit Weight):

1. Shall be as indicated on the Structural Drawings

C. Air Entrainment

1. For concrete exposed to freeze/thaw cycles and/or deicing chemicals (ACI 318 Exposure Classes F1, F2, F3), and concrete intended to be watertight, provide entrained air content

of 6% ± 1.5%, unless specified otherwise. This includes, but is not limited to, concrete at the following locations:

a. Concrete at the exterior of the structure with at least one surface exposed to weather, such as exterior face of grade beams, foundation walls, exterior walls and parapets, exposed columns and edge beams.

b. Floor framing and ramps in parking garages.

c. Loading docks.

d. Balconies and terraces with no waterproofing membrane.

2. For lightweight concrete less than 120 pcf (19 kN/m³) density, air content may be up to 7% regardless of exposure condition.

3. For concrete with a specified compressive strength (f'c) greater than 5000 psi (35MPa), required air content may be reduced to 5% ± 1.5%.

4. Entrained air content noted above shall occur at point of delivery.

5. No entrained air content is required for foundations with no surface exposed to weather.

6. All interior steel trowel finished, normal weight slabs shall have a maximum air content of 3%.

D. Water-Cementitious Material Ratio (w/cm) for Normalweight Concrete

1. The total combined weight of Portland cement and all other supplementary cementitious material shall be used to determine the w/cm.

2. The w/cm shall not exceed the values indicated below, including any water added to meet specified slump in accordance with the requirements of ASTM C 94.

3. Based on Exposure Class, as defined in ACI 318, the following maximum w/cm shall be provided:

a. Exposure Class F0, S0, W0, C0, C1, no maximum

b. Exposure Class F1, max w/cm=0.55

c. Exposure Class S1, W1, max w/cm=0.50

d. Exposure Class F2, S2, S3, max w/cm=0.45

e. Exposure Class F3, C2, max w/cm=0.40

4. Concrete used in slab on grade shall have a maximum w/cm ratio of 0.45.

E. Slump

1. Concrete design mixes shall be proportioned to meet the following slump limitations. Slump should be measured as described in the Testing Agency responsibilities:

    a. Concrete with high range or mid range water-reducing admixture: Concrete slump prior to addition of high range water-reducing admixture shall not exceed 3" +/- 1" (75mm) for normalweight concrete and 4" +/- 1" (100mm) for lightweight concrete. After addition of water-reducing admixture, the concrete shall have a maximum slump of 9" +/- 1" (225mm) unless otherwise approved by the SER.

    b. Concrete without a water-reducing admixture: Slump shall not exceed 4" +/- 1".

F. Self-Consolidating Concrete Slump/Flow: Use for concrete exposed to view and heavily reinforced areas where indicated on the plans, and where conventional mixtures do not provide adequate consolidation. Minimum slump/flow diameter of **20" (500mm)** or as required by the successful test placement onsite, which shall verify proper workability, finish, and setting time. All self-consolidating concrete shall contain the specified high range water-reducing admixture. All self-consolidating concrete shall contain viscosity modifying admixture as required unless proper quantity and grading of fines can be achieved.

G. Chloride Ion Content

1. The total water-soluble chloride ion content of the mix including all constituents shall not exceed the limits defined in ACI 318 unless corrosion inhibiting admixtures are added to the mixture to offset the additional chloride.

2. If the specified level of water-soluble chloride ion content cannot be maintained, appropriate level of corrosion inhibiting admixture shall be added to the mix in accordance with the manufacturer's recommendation to offset the excess amount of chloride at no additional cost to the Owner.

2.3 ADMIXTURES

A. General:

1. Admixtures specified below can be used only when established in the mix design with Design Professionals' prior written approval.

2. Each admixture approved by Design Professionals shall be used in strict compliance with manufacturer's published instructions.

3. Concrete supplier shall certify all admixtures to be compatible with each other. (See Submittals Section in Part 1)

B. Air Entraining Admixture:

1. ASTM C 260

2. Acceptable Products:

    a. MasterAir Series by BASF Corporation

b. Darex Series or Daravair Series by GCP Applied Technologies, Inc.

c. EUCON AEA –92 or EUCON Air Series by Euclid Chemical Company

d. AIR Series or AEA-14 by Sika Corporation

C. Water-Reducing Admixture:

1. ASTM C 494, Type A

2. Acceptable Products:

a. MasterPozzolith Series by BASF Corporation

b. EUCON NW or EUCON WR 91 by Euclid Chemical Company

c. WRDA Series, Zyla Series or Mira Series by GCP Applied Technologies, Inc.

d. Plastocrete Series by Sika Corporation

D. Retarding Admixture:

1. ASTM C 494, Type B

2. Acceptable Products:

a. MasterSet R Series or MasterSet DELVO Series by BASF Corporation

b. EUCON RETARDER 100 by Euclid Chemical Company

c. Daratard 17 by GCP Applied Technologies, Inc.

d. Plastiment Series by Sika Corporation

E. Non Corrosive Accelerating Admixture:

1. ASTM C 494, Type C

2. Acceptable Products:

a. MasterSet FP 20 or MasterSet NC 534 by BASF Corporation

b. ACCELGUARD 80, ACCELGUARD NCA or ACCELGUARD 90 by Euclid Chemical Company

c. Daraset" Series, Polarset, or DCI by GCP Applied Technologies, Inc.

d. Sikaset Series or Rapid-1 by Sika Corporation

F. Water-Reducing and Retarding Admixture:

1. ASTM C 494, Type D

2. Acceptable Products:
    a. MasterSet R Series or MasterSet DELVO Series by BASF Corporation
    b. EUCON RETARDER 75 or EUCON DS by Euclid Chemical Company
    c. Daratard 17 or Recovery Series by GCP Applied Technologies, Inc.
    d. Plastiment Series by Sika Corporation

G. Water-Reducing and Accelerating Admixture:
1. ASTM C 494, Type E
2. Acceptable Products:
    a. MasterSet FP 20 by BASF Corporation
    b. ACCELGUARD 80 or ACCELGUARD 90 by Euclid Chemical Company
    c. Libricon NCA by GCP Applied Technologies, Inc.
    d. Sikaset NC by Sika Corporation

H. Mid-Range Water-Reducing Admixture:
1. ASTM C 494, Type A
2. Acceptable Products:
    a. MasterPolyheed Series by BASF Corporation
    b. Daracem or Mira by GCP Applied Technologies, Inc.
    c. Sikaplast Series or Sikament Series by Sika Corporation
    d. Eucon MR or Eucon MRX by Euclid Chemical Company

I. High-Range Water-Reducing Admixture:
1. ASTM C 494, Type F
2. Acceptable Products:
    a. MasterGlenium Series by BASF Corporation
    b. EUCON 37 or PLASTOL SERIES by Euclid Chemical Company
    c. Daracem or ADVA Series by GCP Applied Technologies, Inc.
    d. Viscocrete Series or Sikament Series by Sika Corporation

J. High-Range Water-Reducing Admixture for production of Control Flow Concrete:

1. ASTM C494 Type A and F and ASTM C1017 Type I

2. Acceptable Product:

a. CONCERA SA8080 by GCP Applied Technologies, Inc.

K. High-Range Water-Reducing and Retarding Admixture:

1. ASTM C 494, Type G

2. Acceptable Products:

a. EUCON 537 by Euclid Chemical Company

b. Daracem Series or Adva Series by GCP Applied Technologies, Inc.

L. Workability Retaining Admixture:

1. ASTM C494, Type S

2. Acceptable Products:

a. MasterSure Z-60 by BASF Corporation

b. Visco Flow-2020 by Sika Corporation

M. Permeability-Reducing Admixture:

1. ASTM C494, Type S

2. Shall be a Portland cement based crystalline capillary waterproofing admixture that reacts in concrete to form non-soluble crystalline hydration products in the capillary pores of concrete,

3. Acceptable Products:

a. MasterLife 300D by BASF Corporation

b. Eucon Vandex AM-10 by Euclid Chemical Company

c. Admix C-Series by Xypex

d. MVRA 900 by ISE Logik

N. Viscosity Modifying Admixture (VMA) for Self-Consolidating Concrete (SCC):

1. ASTM C 494, Type S

2. Acceptable Products:

a. MasterMatrix VMA Seriesby BASF Corporation

b. V-MAR3 by GCP Applied Technologies, Inc.

c. EUCON ABS or EUCON WO or VISCTROL by Euclid Chemical Company

d. Sika Stabilizer-4R by Sika Corporation

O. Corrosion Inhibiting Admixtures:

1. Calcium Nitrite Based: ASTM C 1582 and ASTM C 494, Type C, 30% + 2% solution

a. Acceptable Products:

1) DCI or DCI-Sby GCP Applied Technologies, Inc.

2) MasterLife CI 30 by BASF Corporation

3) EUCON CIA by Euclid Chemical Company

4) Sika-CNI by Sika Corporation

2. Amine Carboxylate Based: ASTM C 1582, which includes ASTM C-494 amine carboxylate

a. Acceptable Product:

1) MCI 2005, MCI 2005 NS, MCI 2006 or MCI 2006 NS by Cortec Corporation

3. Amino Alcohol Based:

a. Acceptable Product:

1) FerroGard 901 by Sika Corporation

2) MasterLife CI 222 by BASF Corporation

P. Alkali-Silica Reaction Inhibiting Admixture:

1. ASTM C 494, Type S

2. Shall contain a nominal lithium nitrate content of 30 percent.

3. Dosage to be determined in accordance with US Army COE CRD-C662

4. Acceptable Products:

a. MasterLife ASR 30 by BASF Corporation

b. Eucon Integral ARC by Euclid Chemical Company

c. RASIR by GCP Applied Technologies

Q. Porosity Inhibiting Admixture:

1. ASTM C494, Type S

2. Sodium silicate free

3. Manufacturer must be able to provide a flooring adhesion guarantee and life of the concrete vapor transmission warranty. In order to obtain warranty, product must be installed in compliance with the manufacturer's published data sheet including but not limited to proper on-site representation, mix design review, concrete testing and installation of vapor retarder for slabs on ground.

4. Acceptable Products:

   a. Barrier One by Concrete Moisture Solutions, Inc.

R. Carbon Dioxide ($C0_2$) Mineralization:

1. Where called for on the drawings or when approved by the SER, provide concrete that has undergone carbonization treatment with carbon dioxide ($C0_2$) during mixing, such that $C0_2$ is chemically mineralized into the concrete.

2. $C0_2$ injected into the mix must be post-industrial $C0_2$ sourced from a nearby emitter. Provide concrete producer's certificate outlining quantity, location and supplier of $C0_2$.

3. Acceptable Product:

   a. Carbon Cure by CarbonCure Technologies.

2.4 ADHESIVES

A. Epoxy Bonding Agent for bonding hardened concrete to hardened concrete (existing concrete damp or dry, at least 28 days old, no surface water):

1. ASTM C 881 Type IV, Grade 1, 2 or 3, Class B or C as appropriate for field temperature conditions.

2. Acceptable Products:

   a. Acceptable Product: Dural 452 Series by Euclid Chemical Company

   b. Rezi-Weld 1000 by W. R. Meadows

   c. Sure Bond J58 by Dayton Superior

B. Epoxy Bonding Agent for bonding freshly mixed concrete to hardened concrete (existing concrete damp or dry, less than 28 days old, no surface water):

1. ASTM C 881, Type V, Grade 1, 2, or 3, Class B or C as appropriate for field temperature conditions.

2. Acceptable Products:

    a. Dural 452 Gel or 452 MV by Euclid Chemical Company

    b. Sikadur 32 Hi-Mod by Sika Corporation

    c. Rezi-Weld 1000 by W. R. Meadows

    d. Sure Bond J58 by Dayton Superior

C. Anti-Corrosive Epoxy Modified Cementitious Bonding Compound and Corrosion Protection of Reinforcement (bonding agent for existing concrete saturated surface dry, no surface water):

    This adhesive shall be a water-based epoxy/cementitious compound for adhesion and corrosion protection of reinforcing members (20 hour maximum open time).

1. Acceptable Products:

    a. DURALPREP AC by Euclid Chemical Company

    b. ARMATEC 110 EpoCem by Sika Corporation

    c. MasterEmaco P124 by BASF Corporation

    d. Perma Prime 3C by Dayton Superior

2.5 CURING COMPOUNDS AND SEALERS

A. Interaction with finishes:

1. See architectural Drawings for finish material applied over concrete.

2. Use only curing and sealer compounds that are compatible with finish, waterproofing or roofing material.

B. Curing and Sealing Compound (VOC Compliant, 350 g/l) :

1. ASTM C1315, Type I, Class A and/or ASTM C 309, Type 1, Class A or B

2. Water based acrylic, clear, 25% solids curing and sealing compound.

3. Acceptable Products:

    a. Super Diamond Clear VOX by Euclid Chemical Company

    b. Cure & Seal 1315 J22WB by Dayton Superior

    c. VOCOMP-25 by W. R. Meadows

    d. Dress & Seal WB 30 or Lumiseal WB by Laticrete International, Inc.

e. **Cure & Seal WB 25 by SpecChem**

C. Surface Applied Vapor Emission Mitigation

1. Shall conform to state and federal VOC regulaions with zero VOC content.

2. Shall provide a 15 year warranty against flooring failure due to negative-side moisture vapor migration of moisture-born alkalinity.

3. Acceptable Products:

a. CS2000 by Creteseal

D. Liquid Densifier/Sealer:

1. The liquid densifier compound shall be a silicate based compound that penetrates and chemically hardens concrete surfaces.

2. Acceptable Products:

a. Euco Diamond Hard by Euclid Chemical Company

b. Acceptable Product: Dayton Superior “Densifier J13”

c. MasterKure HD 200WB by BASF Corporation

d. Liqui-Hard by W. R. Meadows

e. **SpecHard by SpecChem**

E. Evaporation Retarder:

1. Acceptable Products:

a. MasterKure ER50 by BASF Corporation

b. Eucobar by Euclid Chemical Company

c. Sika Film by Sika Corporation

d. **SpecFilm Concentrate by SpecChem**

2.6 DRY SHAKE HARDENERS

A. Mineral Aggregate Hardener:

1. The specified mineral aggregate hardener shall be a factory-blended mixture of specially processed graded non-metallic aggregate.

2. Acceptable Products:

a. Euclid Chemical Company, "Surflex" to be used with “Kurez DR VOX”

b. MasterTop 100 to be used with “MasterKure CC 200WB by BASF Corporation

c. Quartzplate FF to be used with Dress & Seal WB 30 by Laticrete International, Inc.

B. Non-Oxidizing Metallic Hardener:

1. The specified non-oxidizing metallic floor hardener shall be a mixture of specially processed non-rusting aggregates.

2. Acceptable Products:

a. Euclid Chemical Company, “Diamond-Plate” to be used with “Kurez DR VOX”

b. MasterTop 210COR to be used with “MasterKure CC 200WB by BASF Corporation

c. Emeryplate FF to be used with Lumiseal WB by Laticrete International, Inc.

2.7 MISCELLANEOUS CONCRETE AND CONCRETE RELATED PRODUCTS

A. Cementitious Non-Shrink Grout:

1. Provide pre-packaged high-precision, non-shrink, non metallic grout.

2. See General Notes for grout minimum compressive strength.

3. ASTM C 1107

4. Acceptable Products:

a. MasterFlow 928 by BASF Corporation

b. Dry Pack Grout or HI-FLOW GROUT by Euclid Chemical Company

c. Five Star Grout by Five Star Products

d. Sikagrout 328 by Sika Corporation

e. Duragrout by Latticrete International, Inc.

f. **SC Multipurpose Grout by SpecChem**

B. Self-Leveling Concrete Topping - Underlayment for Interior Applications:

1. Use self-leveling underlayment concrete formulated to level concrete floors without shrinking, cracking or spalling, and capable of being placed from feathered edge to 1" (25mm) thickness without aggregate in one pour. If greater than 1" (25mm) thickness is required, aggregate shall be extended with aggregate in accordance with manufacturer's requirements. Appropriate primer shall be utilized for all underlayment applications.

2. Acceptable Products:

    a. K-15 by Ardex

    b. Flo-Top or Super Flo-Top by Euclid Chemical Company

    c. Sika Level Series by Sika Corporation

    d. **SpecFlow by SpecChem**

C. Moisture-Retaining Covers:

1. ASTM C171

2. A naturally colored, non-woven polypropylene fabric with a non-perforated reflective polyethylene coating containing stabilizers to resist degradation from ultraviolet light. Fabric shall exhibit low permeability and high moisture retention.

3. Acceptable Products:

    a. Hydracure S-16 by PNA Construction Technologies, Inc.

    b. Transguard 4000 by Amorlon a Division of Reef Industries , Inc.

    c. UltraCure NCF by Sika Corporation

    d. Top Cure by Transhield

D. Expanded Polystyrene (EPS) used as Fill - Geofoam

1. Material: Rigid, closed cell polystyrene blocks formed by expansion of polystyrene beads by steam.

2. Comply with the requirements of ASTM D 6817

3. Unless noted otherwise on the drawings, provide the following types of EPS:

    a. Fill between a lower slab and a raised slab area: EPS12 -2.2 psi (15 kPa) compressive resistance minimum at 1% deformation, 10 psi (70 kPa) flexural strength minimum

    b. Fill below exterior floor slabs or slabs with truck loading: EPS19 - 5.8 psi (40 kPa) compressive resistance minimum at 1% deformation, 30 psi (200 kPa) flexural strength minimum

4. Thickness as indicated on Drawings.

5. Execution: Conform to manufacturer’s instructions regarding preparation, installation and protection

6. Gripper plates shall be used as needed to restrain EPS from moving laterally in multi-layer applications

7. Contractor shall sequence soil or concrete topping placement to avoid EPS block shift or flotation.

8. Submit the following for review:

   a. Manufacturer's product literature including physical properties in compliance with ASTM D 6817 and type specified

   b. 10 year physical property warranty

9. Submit the following for record:

   a. Summary of test compliance with specified performance characteristics and physical properties

   b. Product Certificates showing evidence of third party quality control

10. Acceptable Manufacturers:

    a. ACH Foam Technologies

    b. Atlas EPS

    c. Universal Construction Foam

E. Non-Slip Aggregate:

1. Abrasive crushed and graded aggregate, high in aluminum oxidegregate which is unaffected by moisture or cleaning compounds.

2. Acceptable Products:

   a. Non-Slip Aggergate by Euclid Chemical Company

   b. Emery Non-Slip by Dayton Superior

   c. A-H Emery Emerundum by Anti-Hydro International, Inc.

2.8 CONCRETE REPAIR MATERIALS

A. Polymer-Modified Repair Mortar

1. The following patching mortars may be used when color match of the adjacent concrete is not required. Prior approval by the Design Professionals is required.

2. Acceptable Products-Horizontal Surfaces:

   a. Tammspatch II or Tamms Thin Patch by Euclid Chemical Company

   b. Sikatop 122 Plus by Sika Corporation

c. Meadow-Patch T1 or T2 or Meadow-Crete GPS by W. R. Meadows

d. Duracrete by Laticrete International, Inc.

e. **Duo Patch by SpecChem**

3. Acceptable Products-Vertical and Overhead Surfaces:

a. MasterEmaco N400 by BASF Corporation

b. Verticoat, Vertacoat Supreme or Dualtop Gel by Euclid Chemical Company

c. SikaTop 123 Plus by Sika Corporation

d. Meadow-Crete GPS by W. R. Meadows

e. **SpecPatch 15 or RepCon V/O by SpecChem**

B. Crack Repair:

a. Euco Qwikstitch or Dural 50 LM by Euclid Chemical Company

b. MasterSeal 630 by BASF Corporation

c. T78 Methyl Methacrylate Crack Sealer by Transpo Industries, Inc.

C. High Strength Flowing Repair Concrete:

1. For forming and pouring large volume repairs, provide shrinkage compensated repair concrete with integral corrosion inhibitor.

2. Minimum compressive strength 8000 psi (56MPa) @ 28-days

3. Prior approval by the Design Professionals is required for cold weather applications

4. Acceptable Products:

a. Eucocrete by Euclid Chemical Company

b. MasterEmaco S 466 CI by BASF Corporation

c. Meadow-Crete FNP by W. R. Meadows

D. Epoxy Injection:

1. ASTM C881

2. Acceptable Products:

a. MasterInject 1380 by BASF Corporation

b. Dural Injection Gel by Euclid Chemical Company

c. Sikadur 35 LV LPL by Sika Corporation

d. Rezi-Weld LV State by W. R.Meadows

E. Pressure-Injected Foam Resin:

1. Acceptable Products:

a. De Neef Sealform PURe by GCP Applied Technologies

b. Crack-Pac Flex-H2O by Simpson Strong-Tie

c. SikaFix HH LV by Sika Corporation

F. Semi Rigid Joint Filler:

1. Acceptable Products:

a. MasterSeal CR 190 by BASF Corporation

b. Euco 700 or Qwikjoint UVR by Euclid Chemical Company

c. MM-80 by Metzger/McGuire

d. Rezi-Weld Flex by W. R, Meadows

e. **Rapid Flex CJ by SpecChem**

G. Methyl Methacrylate (MMA)

1. Acceptable Products:

a. MasterSeal 630 by BASF Corporation

b. Transpo Industries, Inc. “T-78 Methyl Methacrylate Polymer Crack Healer/Sealer”

c. MMA #884 by Epoxy Systems

H. Sealant:

1. Silicone or Polyurethane Sealant (as selected based on project requirements such as loading, traffic, bond, coatings, etc.).

2. Joint to be routed and cleaned per manufacturer’s written directions.

3. Acceptable Products:

a. MasterSeal Sealants by BASF Corporation

b. Sikaflex-1C SL and Loadflex 524 EZ by Sika Corporation

c. Pourthane NS by W. R. Meadows

d. Eucolastic 1NS by Euclid Chemical Company

PART 3 - EXECUTION

3.1 TOLERANCES

A. Work shall conform to all requirements of ACI 117 except as modified by more stringent requirements in the Project Specifications and/or Drawings.

3.2 PREPARATION

A. Subgrade:

1. Dampen subgrades not covered with membrane by sprinkling immediately before placing concrete.

    a. Omit when subgrade is already damp.

2. Do not place on water-saturated subgrade unless placing can be done without damage to subgrade (surface is stable) and loading the subgrade does not drive free water to the surface.

3. Do not place concrete on frozen ground.

B. Forms:

1. Coordinate with Section 031000 Concrete Formwork.

2. Remove dirt, sawdust, nails and other foreign material from formed space.

3. Dampen wood forms by sprinkling immediately before placing.

4. Cool metal forms by sprinkling immediately before placing.

C. Concrete Accessories:

1. Coordinate with Section 031000 Concrete Formwork.

D. Dewatering:

1. Remove water from concrete formwork.

2. Divert any flowing water to sump and remove by pumping.

3. Refer to Division 1 for additional dewatering requirements.

3.3 JOINTS IN CONCRETE

A. Locate construction and contraction joints as indicated on Drawings and on approved joint location submittal.

1. Do not use contraction joints in framed floors or composite slabs.

2. Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Design Professionals.

3. Coordinate location of construction and contraction joints with locations of joints in finish materials where they exist.

    a. Construction and contraction joints in slabs or slab on grade with terrazzo finish must be reviewed and approved by the Design Professionals.

4. Maximum joint spacing is as indicated on Drawings.

B. Construction Joints:

1. Construction joints shall be located within the central third of the span. Any concrete spilling over or through the bulkhead shall be removed at the completion of the pour. All surfaces of the concrete shall have reinforcing extending through the joint.

2. Horizontal Joints: Horizontal construction joints other than those shown on the Drawings will not be permitted unless approved by the Architect.

3. Joint Preparation: Forms shall be removed in time to permit roughening of construction joints of structural members by chipping and wire brushing to remove all loose and foreign material and roughen as indicated on the Drawings. The existing concrete at joints shall either be (a) dampened to the point that the surface is saturated, but all standing water has been removed, promptly followed by placement and vibration of fresh concrete, or (b) not required to be dampened, with one of the specified bonding compounds applied as appropriate for the joint condition, following manufacturer recommendations, with placement and vibration of fresh concrete to follow while the epoxy bonding agent is still tacky. Joints without epoxy bonding agent require fresh concrete with slump 7 inches (180mm) or greater at horizontal joints, and fresh concrete confined to maintain pressure against the joint at vertical joints. Where such conditions are not present, or where applying water to dampen the surface is impractical, use epoxy bonding agent suitable for dry surfaces

C. Isolation Joints:

1. Interrupt structural continuity resulting from bond, reinforcement or keyway at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls and other locations, as indicated.

D. Contraction Joints in Floor Slabs-on-Grade:

1. Maximum slab area controlled by jointing is 400 square feet (35 square meters).

2. Space joints at 36 times slab thickness unless a smaller spacing is indicated on the Drawings, located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

3. Contraction joints can be provided by sawcuts, formed joints or appropriately detailed construction joints.

4. Sawcuts shall be made as soon as possible after slab finishing as may be safely done without dislodging aggregate. The Soff-Cut saw shall be used to a depth of ¼ of slab thickness immediately after final finishing. Conventional saw shall be used as soon as possible after final finish without raveling to a depth as indicated on the Drawings.

5. Where contraction joints coincide with construction joints, detail joint as indicated on Drawings.

E. Joint Fillers: Coordinate with Section 032000 Concrete Reinforcement and Embedded Assemblies and Division 7 requirements.

3.4 MIXING

A. Measurement of Materials: Conforming to ASTM C 94.

B. Mixing: All concrete shall be ready-mixed conforming to ASTM C 94 except as follows:

1. Provide concrete materials, proportions and properties as herein specified in lieu of ASTM C 94.

2. Water, beyond that required by the mix design, shall not be added at the Project site. Addition of water at the Project site shall be made only in the presence of the Testing Agency.

3. Furnish delivery ticket with each load of concrete delivered to the site to the Contractor conforming to the requirements of ASTM C 94.

C. High range water reducing agents (superplasticizer), if added at the batch plant, may be added again at the Project site.

1. If superplasticizers are added at the batch plant, the concrete mix design must account for the delivery time, workability, finishability, and setting time required on the jobsite for proper placing and finishing procedures.

2. If the superplasticizer is redosed at the jobsite in air entrained concrete, air content must be checked after mixing.

D. Discharge of the concrete shall be completed within 1-1/2 hours , after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. If the 1-1/2 hour limit cannot be achieved due to project location or other project specific conditions, hydration control measures to extend the proper workability up to 4 hours maximum can be proposed for approval by the SER. The increased time period along with redosing of the high range water reducer and/or use of hydration controlling/workability retaining admixtures should be agreed upon at the pre-concrete conference.

3.5 CONCRETE PLACEMENT

A. Prior to Concrete Placement:

1. Mechanical vibrators are required and must be available for placing concrete.

2. Remove debris from space to be occupied with concrete.

3. Notify Design Professionals and Testing Agency 48 hours prior to starting concrete placement.

4. Approved mix designs must be maintained on file in Contractor's Field Office.

5. Reinforcement and accessories shall be in proper locations, clean, free of loose scale, dirt or other foreign coatings that may reduce bond to concrete, and in accordance with Section 032000 and Drawings.

6. Fog spray forms, reinforcing steel, and subgrade just before pouring concrete.

7. Do not place concrete having a slump outside of allowable slump range.

8. Place concrete before initial set has occurred, but in no event after it has been discharged from the mixer more than 30 minutes. All concrete shall be placed upon clean, damp surfaces, free from puddled water, or upon properly consolidated fills or upon Controlled Low-Strength Material with a strength between **50 and 1200** psi. Placement upon soft mud or dry earth is not permitted.

9. Unless adequate protection is provided, concrete shall not be placed during rain.

10. Rain water shall not be allowed to increase mixing water or to damage the surface finish.

11. At surfaces left exposed to view, do not use equipment in placing and finishing concrete that contain aluminum in the finishing edges that come in contact with the concrete surface.

12. Keep subgrade moisture uniform without puddles or dry areas.

13. Place vapor retarder directly below slabs on grade as specified in Contract Documents.

B. For Conduits and Pipes Embedded in Concrete:

1. For concrete slab, wall, beam or column, conform to requirements of ACI 318. For variations from these requirements, submit a written request for Design Professionals' review and response.

2. Conduits and pipes shall not be embedded in concrete slabs on steel deck without approval of Design Professional.

3. Provide sleeves for pipes passing vertically through concrete.

4. Do not embed aluminum materials.

5. Do not cut, bend or displace the reinforcement to facilitate placement of embedded pipes and conduits.

C. Pumping: Pumping shall be done in strict accordance with ACI 304.2R.

D. Placing Concrete in Forms:

1. Clean and prepare forms as specified in Section 031000/Concrete Formwork.

2. Place concrete continuously without interruption between predetermined construction and contraction joints in walls.

3. Deposit concrete in forms in horizontal layers no deeper than 24” (600mm) and in a manner to avoid inclined construction joints.

4. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

5. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping.

    a. Use equipment and procedures for consolidation of concrete in accordance with ACI 309R.

6. Do not use vibrators to move fresh concrete laterally inside forms from discharge point; shift discharge point as needed.

7. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine.

8. Place vibrators to rapidly penetrate placed layer and at least 6" (150mm) into preceding layer.

9. Do not insert vibrators into lower layers of concrete that have begun to set.

10. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

11. Do not vibrate Self-Consolidating Concrete (SCC).

E. Placing Concrete Slabs:

1. Place concrete continuously without interruption between predetermined construction and contraction joints in floors.

    a. Place slabs on grade by the long strip cast method. Refer to ACI 302.1R for recommended methods of placement.

2. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.

3. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.

4. Bring slab surfaces to correct level with a straightedge and strike off.

    a. Use highway straight edges, bullfloats or darbies to smooth surface free of humps or hollows.

    b. Do not disturb slab surfaces prior to beginning finishing operations.

5. Maintain reinforcing in proper position on chairs during concrete placement.

6. Do not place materials on slabs or impose loads during period of setting.

F. Placing Concrete on Steel Decks

1. Exercise care during concrete placement on steel decks to prevent concentrated loads or high pile-ups of concrete and to avoid impacts caused by dumping or dropping of concrete on steel decks.

2. Do not use buggies on unprotected areas of deck. If buggies are used to place concrete, furnish and install planked runways to protect deck from damage.

G. Placing Concrete at Construction Joints:

1. To secure full bond at construction joints, surfaces to receive concrete in a subsequent placement shall be left in a roughened state or intentionally roughened by raking while plastic or brushing and chipping immediately after removal.

2. Before new concrete is placed in contact, surfaces of hardened concrete already placed shall be thoroughly cleaned of foreign materials and laitance.

3. At hardened concrete at joints where no bonding agents are used, dampen concrete to achieve a saturated surface dry condition. Leave no standing water. Place and vibrate concrete (slump 7 inches (180mm) or greater) against horizontal joints. Place and vibrate flowing concrete (slump 8 to 10 inches (200 to 250mm)) while maintaining pressure against vertical joints by confinement.

4. At hardened concrete with joints not meeting conditions required for no bonding agents, apply appropriate specified bonding agent for conditions present including age and moisture per manufacturer’s specifications. Place new concrete while the bonding agent is still tacky.

H. Floor Topping Slabs:

1. Place concrete topping slab to required lines and levels.

2. Minimum topping slab thickness is 2” (50mm).

3. Place dividers, edge strips and other items to be cast in place.

4. At all topping slabs, remove deleterious material before placing topping slab.

5. All topping slabs shall be bonded unless noted as unbonded on the drawings.

6. Bonded topping slabs should be placed directly against a properly prepared base slab. Proper preparation of the base slab consists of cleaning and removal of all deleterious material roughening the surface to a concrete surface profile of CSP5 or CSP6 and overnight prewetting of the newly cleaned, exposed surface with no standing water present. The surface abrasion method should not cause micro cracking of the top of the base slab.

7. Immediately before placing the bonded topping slab, scrub an even, 1/16" to 1/8" layer of portland cement/sand/water bonding grout over the entire surface to receive the topping slab. Do no allow the bonding grout to dry to a whitish appearance before the topping slab is placed.

8. Where topping slab is noted on Drawings as unbonded the topping should be placed on bond breaker consisting of two sheets of plastic film.

9. Topping mix shall have a maximum water/cement ratio of 0.45.

10. Topping mix shall have a maximum shrinkage of 0.04% at 28 days. If the topping slab is to be exposed and polished, the maximum shrinkage shall be 0.02%.

11. The topping slab shall be moist cured for a minimum of 36 hours after placement.

12. Bonded topping slabs shall have contraction joints located to match any joints in the base slab. All topping slabs shall be jointed to eliminate restraint conditions such as re-entrant corners and to isolate the slab from columns, walls, etc. and to limit the maximum distance between joints to 15 feet (4570mm).

I. Cold-Weather Placement:

1. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306R and as specified in this section.

2. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (27°C), at point of placement.

3. Do not use frozen materials or materials containing ice or snow.

   a. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

4. Remove frost, snow and ice from forms, reinforcement and other embedments immediately prior to concrete placement.

5. Use only the specified non-corrosive accelerating admixture previously approved as part of the cold weather mixture. Addition of calcium chloride, salt, thiocyanates or admixtures containing more than 0.05 percent chloride ions is not permitted.

6. Freeze Resistant Concrete per ASTM C1622 and Chapter 9 of ACI 212.3R may be used if approved by SER. The contractor shall prepare a plan for placing, finishing and curing procedures that assure the specified hardened properties are achieved.

J. Hot-Weather Placement:

1. Hot weather is defined as air temperature which exceeds 90°F (32°C) or any combination of high temperature, low humidity and/or high wind velocity which causes a rate of evaporation in excess of 0.2 pounds per square feet per hour (1.0 kg/m² per hour) as determined by ACI 305R.

2. When hot weather conditions exist that would impair quality and strength of concrete, place concrete in compliance with ACI 305R and as specified in this section.

3. Cool ingredients before mixing to maintain concrete temperature at time of placement below **95°F (35°C).**

4. Mixing water may be chilled, or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.

5. Use of liquid nitrogen to cool concrete is Contractor's option.

6. When concrete placement will occur late in the day and reinforcing steel will be heated by the sun, cover reinforcing steel with water-soaked burlap so that steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

7. When concrete operations must be performed in direct sun, wind, high temperatures, low relative humidity, or other adverse placing conditions, the specified evaporation retarder shall be applied one or more times during the finishing operation to prevent plastic cracking.

3.6 CONCRETE FINISHES

A. General:

1. Comply with recommendations for concrete finishing established by ACI 302.1R and ACI 304R.

2. Comply with dimensional tolerance limitations given by ACI 117.

3. For shored floor or slab on grade construction: Floor flatness/floor levelness tolerance compliance testing is to be performed prior to the removal of shores and forms but not later than **72** hours of concrete placement by Testing Agency.

4. See architectural Drawings for locations of the various finishes listed below.

5. Comply with the specified overall SOF_F and SOF_L values listed below:

   a. The specified overall area shall be each individual floor.

   b. F_F/F_L shall be measured in accordance with ASTM E 1155.

   c. The specified minimum local values of MLF_F/MLF_L shall be 3/5 of the SOF_F/SOF_L values listed below.

   d. If an individual test section measures less than either of the specified minimum local MLF_F/ MLF_L numbers, that section may be rejected and remedial measures may be required as specified in CONCRETE SURFACE REPAIRS.

e. If the composite value of the test surface measures less than either of the specified overall SOF_F/SOF_L numbers, then the entire slab may be rejected and remedial measures may be required.

f. F_L numbers shall only apply to supported slabs if the tested with all of the original shoring in place, prior to shoring removal/reshoring.

g. F_L numbers shall not apply to unshored slabs or shored slabs with camber.

B. Finish for monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile and other bonded applied cementitious finish flooring material, as indicated on architectural Drawings:

1. Scratch Finish.

a. Finish surface to overall value of SOF_F=20 and SOF_L=15.

b. Slope surfaces uniformly to drains where required.

c. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

C. Finish for monolithic slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, sand-bed terrazzo as indicated on architectural Drawings:

1. Float Finish.

a. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating.

b. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both.

c. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units.

d. Finish surfaces to overall value of SOF_F=20 and SOF_L=15.

e. Cut down high spots and fill low spots.

f. Uniformly slope surfaces to drains.

g. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

D. Finishes for Pedestrian Sidewalks and Ramps, Exterior Platforms, Steps, as indicated on architectural Drawings:

1. Sidewalks and Curbs: Light-to-medium broom finish applied with fiber-bristle broom perpendicular to direction of main traffic route immediately after float finishing.

2. Ramps: Scored finish as applied perpendicular to direction of main traffic route immediately after float finishing.

3. Finish surface to overall value of SOF_F=20 and SOF_L=15.

4. Texture shall be approved by the Design Professionals from sample panels.

E. Finish for interior floor slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, paint or another thin film-finish coating system, as indicated on architectural Drawings:

1. Trowel Finish.

a. After floating, begin first trowel-finish operation using a power-driven trowel.

b. Begin final troweling when surface produces a ringing sound as trowel is moved over surface.

c. The final hand-troweling operation shall result in a smooth surface, free of trowel marks, uniform in texture and appearance.

d. Grind smooth any surface defects that would telegraph through applied floor covering system.

2. Finish surface to overall value of SOF_F=25 and SOF_L=20.

3. Floor Slopes: Where drains occur, slope floor slabs uniformly to drains, maintaining scheduled slab thickness.

4. Floor Edges at Expansion Joints: Tool edges minimum 3/8" (10mm).

5. Defects: Remove defects of sufficient magnitude to show through floor covering by grinding.

6. Floor Hardener: Use only where scheduled and in accordance with manufacturer's published instructions.

7. Dry Cement: Shall not be used during finishing.

F. Finish for thin set ceramic tile or thin set epoxy terrazzo, as indicated on architectural Drawings:

1. Trowel and Fine Broom Finish:

a. Apply a trowel finish as specified.

b. Immediately follow by slightly scarifying the surface with a fine broom.

2. Finish surface to overall value of SOF_F=35 and SOF_L=25.

G. Finishes for Parking Garage Deck, Ramps, Loading Docks:

1. Highway straight edge immediately after screeding concrete.

2. Finish surface to overall values of SOF_F=20 and SOF_L=15.

3. For Slabs Not Receiving Deck Coating: Medium broom finish with ridges not to exceed 1/8" (3mm) in height. Texture shall be as approved by the Design Professionals from sample panels.

4. For Slabs Scheduled to Receive Deck Coating: Smooth floated finish which must be verified with coating manufacturer before finishing the slab.

    a. Coordinate with deck coating specified in Division 7.

5. Auto Ramps: Rough texture applied perpendicular to direction of traffic. Texture shall be as approved by the Design Professionals from sample panels.

H. Finishes Equipment and Housekeeping Pads

1. Coordinate finish surface to meet equipment manufacturer requirements, if any, for flatness and levelness.

I. Tolerances at Slab Discontinuities

1. Within 2 ft (600mm) of slab boundaries, construction joints, isolation joints, block-outs, penetrations or other similar discontinuities, where required for travel paths, installation of finishes and partitions, or any other requirements indicated in the Contract Documents, the following equivalent straightedge tolerances shall apply:

    a. Specified local MLF_F = 12, use ¼” (6mm) over 4 ft (1200mm), no offset greater than 1/16” (2mm)

    b. Specified local MLF_F = 15, use 1/8” (3mm) over 4 ft (1200mm), no offset greater than 1/32” (0.8mm)

J. Dry Shake Finish:

1. Non-slip aggregate where indicated on Drawings.

2. Non-oxidizing metallic hardener on loading docks at a rate of 1.5 lbs. per sq. ft. (7.3 kg/m²) and in other locations so noted on the Drawings.

3. Mineral aggregate hardener at a rate of 1.2 lbs. per sq. ft. (5.8 kg/m²) where noted on the Drawings.

4. Final finish type, method and tolerance as applicable by location and use.

5. Dry shake finish will be applied only where scheduled and in accordance with the manufacturer's published instructions and the methods and procedures agreed upon at the pre-installation conference.

K. Rough Formed Finish:

1. Acceptable for formed concrete surfaces not exposed-to-view in the finish work or by other construction, unless otherwise indicated.

2. Concrete surface shall have texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4" (6mm) in height rubbed down or chipped off.

L. Architectural Concrete Finish:

1. Using self-consolidating concrete, provide smooth, uniform finish upon form removal with no patching, stoning or other form of repair except washing permitted unless otherwise noted for walls, columns and other surfaces exposed to view. The surface shall match the approved jobsite mock-up panel.

M. Smooth Formed Finish:

1. Required for formed concrete surfaces exposed to view, or scheduled to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system, as indicated on architectural Drawings:

2. Surface is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

3. Repair and patch tie holes and defects. Remove fins and other projections completely.

N. Smooth Rubbed Finish:

1. "Smooth Rubbed" finish shall consist of a finish free of fins, joint marks smoothed off, blemishes removed and surfaces left smooth and unmarred.

2. Provide smooth rubbed finish to scheduled concrete surfaces, as indicated on architectural Drawings, which have received smooth form finish treatment not later than one day after form removal.

3. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced.

a. Do not apply cement grout other than that created by the rubbing process.

O. Grout-Cleaned Finish:

1. Provide grout-cleaned finish on scheduled concrete surfaces, as indicated on architectural Drawings, that have received smooth-formed finish treatment.

2. Combine one part Portland Cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint.

3. Blend standard Portland Cement and white Portland Cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.

4. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes.

5. Remove excess grout by scraping and rubbing with clean burlap.

6. Keep surface damp by fog spray for at least 36 hours after rubbing.

P. Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces.

2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.7 CURING AND PROTECTION

A. Normal Conditions:

1. Protect concrete from premature drying, excessive hot or cold temperature, and damage.

2. Concrete shall be kept continuously moist and above 50°F (10°C) for seven days (ASTM C 150 Type I cement) or for 10 days (ASTM C 150 Type II cement). High early strength concrete usage shall be maintained over 50°F (10°C) for three days.

3. Concrete and concrete patching materials shall be cured according to manufacturers published recommendations.

4. Begin curing as soon as free water has disappeared from concrete surface and finishing has been completed.

5. Curing Methods: Cure concrete by curing compound, moist curing, moisture-retaining cover curing, or by combining these methods, as specified. Under extreme hot/dry or windy/dry conditions, moist curing and/or moisture-retaining cover curing should be used.

a. Curing compound is an acceptable form of curing if all of the following requirements are met:

1) Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). In accordance with all manufacturer’s instructions.

2) Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions.

3) Recoat areas subjected to heavy rainfall within 3 hours after initial application.

4) Maintain continuity of coating and repair damage during curing period.

5) Use curing and sealing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

6) Floors to receive covering shall be cleaned thoroughly using a power scrubber and industrial strength detergent.

7) Hand-brooming and sweeping is not sufficient.

8) Strippable curing compound may be used in lieu of a moist curing method when approved by the Design Professionals.

b. Provide moist curing by the following methods:

1) Keep concrete surface continuously wet by covering with water.

2) Use continuous water-fog spray.

3) Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4" (100mm) lap over adjacent absorptive covers.

c. Provide moisture-retaining cover curing as follows:

1) Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" (75mm) and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period using cover material and waterproof tape

6. Cure slabs on grade, concrete toppings, concrete pour strips, supported slabs, walls and columns, not subject to conditions of hot or cold weather concreting, in accordance with ACI 308.

7. Cure surfaces exposed to deicing salts, brackish water, etc., such as loading dock slabs, parking garage slabs and ramps in accordance with ACI 308 recommendations for moist curing.

8. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by leaving forms in place for the full curing period (equivalent to moist curing).

a. If forms are removed prior to completion of full curing period, continue curing by methods specified above for Unformed Surfaces, as applicable.

B. Cold-Weather Protection:

1. When concrete is placed under conditions of cold weather concreting (defined as a period when the mean daily temperature drops below 40°F (4°C) for more than 3 successive days), take additional precautions as specified in ACI 306R when placing, curing, monitoring and protecting the fresh concrete.

C. Hot-Weather Protection:

1. When concrete is placed under conditions of hot weather concreting, provide extra protection of the concrete against excessive placement temperatures and excessive drying throughout the placing and curing operations with an evaporation retarder.

a. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

2. Hot weather curing is required if hot weather conditions occur within a 24-hour period after completion of concrete placement.

D. Floor surfaces, wherever indicated by weather conditions, shall be sprinkled during the interval between finishing operation and the start of curing to positively ensure against the possibility of surface drying.

3.8 CONCRETE REPAIRS

A. Perform patching and repairs in accordance with ACI 301.

B. Contractor shall submit patching and repair methods and materials for review by Design Professionals.

C. When complete, all patches and repairs shall match color and texture of adjoining surfaces.

D. At surfaces that are exposed to view, prepare test areas at inconspicuous locations for review by Design Professionals to verify repair color and texture match before proceeding with repair.

E. Apply all patching and repair materials in accordance with manufacturer’s specifications.

F. Repairing Cracks In Formed and Unformed Surfaces:

1. Contractor shall notify Design Professionals of all cracks wider than 0.02” (0.50mm) and all cracks wider than 0.01” (0.25mm) that occur in a group of at least three cracks within twelve inches (300mm), in concrete. If Design Professionals deem repairs necessary, Contractor shall be responsible for repairing all such cracks per Design Professionals recommendation at no expense to the Owner. Repairs will generally require one or more of the following: Epoxy Injection, Semi-Rigid Epoxy, Pressure Injected Foam Resin, Methyl Methacrylate and/or Sealant with joint routed and cleaned. See Concrete Repair Materials section of this Specification for acceptable products

G. Repairing Formed Surfaces

1. Immediately after stripping forms, patch all honeycombing, defective joints, voids, etc. before the concrete is thoroughly dry.

2. Remove all burrs, fins, and ridges before the concrete is thoroughly dry.

3. Remove stains from rust, grease and oils, from release agents, etc.

4. Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of the Design Professionals.

a. Surface defects, include color and texture irregularities, cracks as defined above, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

b. Chip away defective areas, honeycomb, rock pockets, voids over 1/4" (6mm) in any dimension and holes left by tie rods and bolts, down to solid concrete but in no case to a depth less than 1" (25mm) and saw-cut edges to prevent feather edging of fill material.

5. Repair concealed formed surfaces, where possible, containing defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

6. Clean out form tie holes and fill with dry pack mortar or precast cone plugs secured in place with bonding agent.

7. If honeycombing exposes reinforcement, chip to provide clear space at least 3/4" (20mm) wide all around steel to allow proper bond.

H. Repairing Unformed Surfaces:

1. High and Low areas in concrete surfaces which are in excess of specified tolerances shall be leveled or ground-smooth.

a. Correct high areas by grinding after concrete has cured at least 14 days.

b. Correct low areas by applying leveling material. Finish leveling material as specified in this section.

2. Repair surfaces containing defects that affect durability of concrete.

a. Surface defects include crazing, cracks as defined above, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.

3. Repair defective areas, except random cracks and single holes not exceeding 1" (25mm) in diameter, by cutting out and replacing with fresh concrete.

a. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4" (20mm) clearance all around.

I. Filling In: Fill in holes and openings left in concrete for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place.

3.9 EVALUATION AND ACCEPTANCE OF CONCRETE

A. In accordance with ACI 301, except where otherwise specified.

B. If, at any time during construction, the concrete resulting from the approved mix design deviates from Specification requirements for any reason, such as lack of workability, or insufficient strength, the Contractor shall have his laboratory verify the deficiency and modify the mix design, until the specified concrete is obtained. Modified mix to be submitted for approval per Part 1 - SUBMITTALS.

3.10 CORRECTIVE MEASURES

A. Conflicts: The Contractor shall be solely responsible for errors of detailing, fabrication, and placement of reinforcement steel; placement of inserts and other embedded items; and the structural adequacy of all formwork.

B. Compensation for Additional Services: Should additional work by Design Professionals such as design, documentation, meetings and/or site visits be required which are necessitated by failure of the Contractor to perform the work in accordance with the Contract Documents either developing corrective actions or reviewing corrective actions developed by others, the Contractor is responsible for paying for additional work performed by the Design Professionals at their standard firm-wide billing rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.

[Balance of page blank; see form on next page]

CONCRETE MIX DESIGN SUBMITTAL FORM

Project: _____

City: _____

General Contractor: _____

Concrete Contractor: _____

Concrete Strength: _____

Use/Location on Job: _____

Supplier's Mix Designation: _____

Design Mix Information **(Please check one):** *Refer to ACI 301 for requirements of data used to substantiate strength calculations.*

Field Experience (Based on Standard Deviation Analysis): _____

Trial Mixture Test Data: _____

Design Characteristics:

Density: _____ Pcf (kg/m3)

Strength: _____ Psi (MPa) (28 day)

Air: _____ % (specified)

Materials:	**Type/Source**	**Specific Gravity**	**Weight (lb)**	**Absolute Vol. (cu. ft.) (cu. m)**
Cement:				
Fly ash:				
Slag (GGBFS)				
Microsilica:				
Coarse Aggregate:				
Fine Aggregate:				
Water:				
Air:				
Other:				
TOTAL:				27.0 cu. ft. (1.0 m3)
Water/Cementitious Material Ratio (lbs. (kg) water / lbs. (kg) cementitious material) =				%

Admixtures:	**Manufacturer**	**ASTM**	**Dosage (oz/cwt)**
Water Reducer:			
Air Entraining Agent:			
High Range Water Reducer			
Non-corrosive Accelerator:			
Other:			

Slump before HRWR: _____ Inches (mm)

Slump after HRWR: _____ Inches (mm)

Standard Deviation Analysis (from experience records):

No. of Test Cylinders Evaluated: _____

Standard Deviation: _____

Required Average Strength f'cr

Average Strength by Tests

Equation Used (ACI Chapter 5)

(Refer to ACI 318 for increased deviation factor when less than 30 tests are available)

TRIAL MIXTURE TEST DATA

Compressive Strength:	**Age (days)**	**Mix #1**	**Mix #2**	**Mix #3**
	28 [56] [90]	psi (MPa)	psi (MPa)	psi (MPa)
	28 [56] [90]	psi (MPa)	psi (MPa)	psi (MPa)
	28 [56] [90]	psi (MPa)	psi (MPa)	psi (MPa)
	Average	psi (MPa)	psi (MPa)	psi (MPa)
Required Average Strength f'cr				
Average Strength by Tests				
Equation Used (ACI Chapter 5)				

REQUIRED ATTACHMENTS	***Please check***
Coarse Aggregate Gradation Report	
Fine Aggregate Gradation Report	
Fly Ash (or other Supplementary Cementitious Material) Certification	
Concrete Compressive Strength Data or Trial Mixture Test Data	
Admixture Compatibility certification letters	
Chloride Ion Content Certification	
Alkali Aggregate Reactivity Certification	
Shrinkage Test Reports	

SUBMITTED BY:

Name: _____

Address: _____

_____

Phone no.: _____

Main Plant Location: _____

Miles from Project: _____

Secondary Plant Location: _____

Miles from Project: _____

_____

Date: _____

Certification by Concrete Supplier:
Signature: _____

Print Name: _____

PE License Number and Expiration Date (print or stamp) _____

Structural Substitution Request Form – to be completed by Contractor

Project:		
Date:		Substitution Request #
Requesting Contractor:		Pages Attached (including this form)

1. Description of Requested Substitution:

2. Related Drawings and Specification Sections:

3. Rationale or Benefit Anticipated:

4. Effect on Construction Schedule[1] (check one): ☐ NONE ☐ See Attached

5. Effect on Owner's Cost[2] attach data (check one): ☐ CREDIT TO OWNER ☐ EXTRA

6. Effect on Construction Documents[3] (design work anticipated): ☐ NONE ☐ See Attached

7. Requesting Contractor Agrees to Pay for Design Changes (check): ☐ YES ☐ NO ☐ NOT APPLICABLE

8. Effect on Other Trades[4]:

9. Effect of Substitution on Manufacturer's Warranty (check): ☐ NONE ☐ See Attachment

Signature[5]: Date:

Company:

General Contractor Signature[5]: Date:

Notes:

1. Contractor is responsible for means and methods and any problems that may arise from making the requested substitution.
2. This is **NOT A CHANGE ORDER FORM**. A separate form is required to adjust costs and/or schedules.
3. Contractor is responsible for any design impacts that may arise from this substitution, including redesign efforts.
4. Contractor is responsible for effects on other trades from this substitution;
   General Contractor must review and agree effects on other trades are fairly represented in items 4-9.
5. Signature by a person having authority to legally bind his/her company to the above terms. Otherwise this request is void
6. All items in form must be completed for substitution request to be considered.

Request Review Responses (completed by Architect and/or Engineer(s)):

ACCEPTED	ACCEPTED AS NOTED	REJECTED	INSUFFICIENT DATA TO SUPPORT REQUEST	ENGINEER / ARCH / MEP SIGNATURE	DATE

Engineer/Architect Comments:

END OF SECTION

SECTION 07 41 13.16 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes standing-seam metal roof panels.

B. Related Sections:

1. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.

1.2 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 type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal 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.

D. Retain strippable protective covering on metal panels during installation.

1.7 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.8 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

A. Special Warranty on 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: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

B. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A- 90.
2. Hail Resistance: SH.

2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.

B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following, or a comparable system by another manufacturer.

a. Berridge Manufacturing Company; Berridge Zee-Lock Double Lock.
b. Centria; SRS3 16”.

2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel

sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

a. Nominal Thickness: 0.034 inch (22 gage).
b. Exterior Finish: Two-coat fluoropolymer.
c. Color: Matte Black.

3. Clips: Two-piece floating to accommodate thermal movement.

a. Material: 0.028-inch- nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

4. Joint Type: Double folded.
5. Panel Coverage: 16 inches.
6. Panel Height: 2.0-3.0 inches.
7. Slope: Can accommodate 1/2-inch per foot slope.

C. Curved Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following, or a comparable system by another manufacturer.

a. Berridge Manufacturing Company; Barrel Roof.
b. Centria; SRS3 16”.

c. AEP Span Curved Span-Lok.

2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

a. Nominal **Galvanized** Thickness: 0.034 inch (22 gage)**, minimum**.
b. Exterior Finish: Two-coat fluoropolymer.
c. Color: **As indicated on Drawings.** ~~As selected by Architect from manufacturer’s full range.~~

3. Clips: Two-piece floating to accommodate thermal movement.

a. Material: 0.028-inch- nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

4. Joint Type: Double folded.
5. Panel Coverage: 16 inches.
6. Panel Height: 2.0-3.0 inches.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. 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 panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels 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. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch-long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.

E. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot-long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.

F. Panel Fasteners: Self-tapping screws designed to withstand design loads.

G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same

profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

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.
2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

F. Accessory Installation: 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 panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. 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 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 achieve 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 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).

H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

I. Downspouts: Join sections with 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. Connect downspouts to underground drainage system indicated.

3.4 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units 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.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 07 42 13.19 - INSULATED METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Foamed-insulation-core metal wall panels.

B. Related Requirements:

1. Section 07 42 13.53 "Metal Soffit Panels" for metal panels used in horizontal soffit applications.

1.2 COORDINATION

A. Coordinate requirements for attachment locations and spacing with the installation of attachment clips in Section 07 21 00 “Thermal Insulation” to ensure proper sequencing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.
8. Review procedures for repair of metal panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 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 type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical metal panel assembly, including corner, soffits, supports, attachments, and accessories.
2. Water-Spray Test: Conduct water-spray test of metal panel assembly mockup, testing for water penetration according to AAMA 501.2.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal 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.

D. Retain strippable protective covering on metal panels during installation.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures including rupturing, cracking, or puncturing.
    b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on 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: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 72:

1. Wind Loads: As indicated on Drawings.
2. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.04 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft.

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base 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. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E 119.
2. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies.
3. Radiant Heat Exposure: No ignition when tested according to NFPA 268.
4. Potential Heat: Acceptable level when tested according to NFPA 259.
5. Surface-Burning Characteristics: Provide wall panels with a flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E 84.

2.2 FOAMED-INSULATION-CORE METAL WALL PANELS

A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

1. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent, 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.
   b. Density: 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D 1622.
   c. Compressive Strength: Minimum 20 psi when tested according to ASTM D 1621.
   d. Shear Strength: 26 psi when tested according to ASTM C 273/C 273M.

B. Concealed-Fastener, Foamed-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.

1. Basis-of-Design Product: Subject to compliance with requirements, provide CENTRIA Architectural Systems; Formawall **FWDS, arranged vertically, 12-inches wide, smooth striated,** ~~Dimension Series~~ or a comparable product by one of the following:

   a. Insulated Panel Systems (IPS).
   b. Kingspan Insulated Panels.
   c. MBCI; a division of NCI Group, Inc.

2. Metallic-Coated Steel Sheet: Facings of zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

   a. Nominal Thickness: 0.034 inch.
   b. Exterior Finish: 2-coat **and 3-coat** fluoropolymer**s**.

      1) Colors: ~~As selected by Architect.~~**As indicated on Drawings.**
         a) EX-MT1: 3-coat fluoropolymer.
         b) EX-MT2: 3-coat fluoropolymer.

      c) EX-MT4: 2-coat fluoropolymer.

   c. Interior Finish: Siliconized polyester.

3. Panel Thickness: 2.5 inches.
4. Thermal-Resistance Value (Panel R-Value): 20 according to ASTM C 1363.

5. Provide panels in lengths to avoid horizontal joints.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. 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 panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Honeycomb-Core Metal Wall Panels: Fabricate panels using manufacturer's standard thermosetting structural adhesive in a lamination process that bonds panel under minimum 10-psi pressure. Use of contact adhesives with pinch-roll process is unacceptable.

1. Panel Bow Tolerance: Not more than 0.5 percent of panel width or length.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

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.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.

6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
2. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."

3.4 INSULATED METAL WALL PANEL INSTALLATION

A. General: 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 for weather seal.

1. Fasten foamed-insulation-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
2. Apply panels and associated items true to line for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
3. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
4. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
5. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
6. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.
7. Apply snap-on battens to exposed-fastener, insulated-core metal wall panel seams to conceal fasteners.

B. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.

1. Install clips to supports with self-tapping fasteners.

C. Accessory Installation: 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 panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

D. 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. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without 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 achieve waterproof 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 expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration according to AAMA 501.2.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

D. Metal wall panels will be considered defective if they do not pass test and inspections.

E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 11 24 29 - FACILITY FALL PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes anchor-type and horizontal lifeline-type fall restraint systems for Owner's employee fall prevention in areas indicated on Drawings, including but not limited to the following:

1. Roof access areas.

B. Owner-Furnished Components: Components of fall restraint systems furnished by Owner include, but are not limited to, the following:

1. Lanyards
2. Connectors
3. Body Belts
4. Body Harnesses

1.2 DEFINITIONS

A. Fall Restraint System: Fall protection system that prevents the user from falling any distance. The system is comprised of either a body belt or body harness, along with an anchorage, connectors and other necessary equipment. The other components typically include a lanyard, and may also include a lifeline and other devices.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Product Schedule: For fall restraint systems.

D. Delegated-Design Submittal: For each fall restraint system.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer, testing agency, and professional engineer.

B. Welding certificates.

C. Product Certificates: For each fall restraint system component complying with referenced standards.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fall restraint systems to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of engineering, fabricating, and installing fall restraint systems that meet or exceed performance requirements indicated and of documenting this performance by test reports, and calculations.

B. Installer Qualifications: Manufacturer, or an authorized representative who is trained and approved by manufacturer.

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 for testing indicated.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain components, including related accessories, from single source from single manufacturer.

B. 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. Evan Corporation, Inc.
2. Fallsafe.net.

3. Flexible Lifeline Systems.
4. Spider; A Division of SafeWorks, LLC.
5. Tritech Fall Protection Systems.
6. Unistrut Fall Protection.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design fall restraint systems.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F.

C. Capacities and Characteristics: Design systems according to project design loads indicated on the Drawings, and complying with requirements of the ANSI/ASSE Z359 “Fall Protection Code,” OSHA, and authorities having jurisdiction.

2.3 COMPONENTS

A. General: Provide components necessary for complete fall restraint systems that meet or exceed performance requirements.

2.4 ACCESSORIES

A. Anchors, Fasteners, Fittings, Hardware, and Installation Accessories: Complying with performance requirements indicated and suitable for exposure conditions, supporting structure, anchoring substrates, and installation methods indicated. Corrosion-resistant, compatible, nonstaining materials. Where exposed to view, provide finish and color as selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install fall restraint systems to comply with performance requirements and requirements indicated on Shop Drawings.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections required by authorities having jurisdiction, and required of the referenced standards for facility fall protection.

B. Fall restraint system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 133419 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel framing.

2. Accessories.

B. Related Requirements:

1. Section 072100 “Thermal Insulation”

2. Section 074113.16 “Standing-Seam Metal Roof Panels”

3. Section 074212.19 “Insulated Metal Wall Panels”

4. Section 074293 “Soffit Panels”

5. Section 081113 “Hollow Metal Doors and Frames”

6. Section 083613 "Sectional Doors"

7. Section 084513 “Structured-Polycarbonate Panel Assemblies”

1.2 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 standards referenced by this Section.

1.3 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Section 033000 "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.

1.4 PREINSTALLATION MEETINGS

A. 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 and impact on construction schedule.

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.

1.5 ACTION SUBMITTALS

A. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details and the following:

1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods 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.

    a. Show provisions for attaching mezzanines, roof curbs, service walkways, platforms and pipe racks.

B. Delegated-Design Submittal: For metal building systems.

1. Include analysis data indicating compliance with performance requirements and design data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and erector.

B. Welding certificates.

C. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.

2. Order number.

3. Name of manufacturer.

4. Name of Contractor.

5. Building dimensions including width, length, height, and roof slope.

6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.

7. Governing building code and year of edition.

8. 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).

9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.

10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

D. 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.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Accreditation: Manufacturer's facility accredited according to the International Accreditation Service's AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."

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. 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."

1.9 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Varco Pruden Buildings; 3200 Players Club Circle; Memphis, TN 38125; Toll Free Tel: 866-538-0012; Tel: 901-748-8000; Fax: 901-748-9323; Email: request info (vpsales@vp.com); Web: www.vp.com

B. Butler Manufacturing Company; a division of Blue Scope Buildings North America, Inc. 1540 Genessee Street #1069, Kansas City, MO 64102; Web: http://www.butlermfg.com

C. Chief Buildings; Chief Industries, Inc. 3942 W. Old Highway 30, Grand Island, NE 68802; (308) 389-7200; Web: http://www.chiefbuildings.com

D. Star Building Systems: a division of NCI Building Systems, Inc. 8600 South Interstate 35, Oklahoma City, OK 73143; Web: http://www.starbuildings.com

E. Others as approved by Design/Builder

F. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

G. American Buildings; a Nucor Company; 2101 East Main Street, El Paso, IL 61738; Tel: (309) 270 3518; Fax: (309) 527-1522; Web: https://www.americanbuildings.com/

H. Behlen Building Systems; 4025 E. 23rd St., Columbus, NE 68601; Tel: (800) 228-0340; Web: http://www.behlenbuildingsystems.com

I. **Steel Tech of the Ozarks, LLC; 511 South Kyler St., Monett, MO 65708; Tel: (417) 476-2600; Web: https://www.steeltech.io/**

2.2 SYSTEM DESCRIPTION

A. Provide a complete, integrated set of 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.

B. Primary-Frame Type:

1. Rigid Clear Span: Solid-member, structural-framing system without 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: Manufacturer's standard height, as indicated by nominal height on Drawings.

F. Bay Spacing: As indicated on Drawings.

G. Roof Slope: As Indicated on Drawings..

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal building system.

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. Deflection and Drift Limits: Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC Steel Design Guide No. 3 "Serviceability Design Considerations for Steel Buildings."

3. Deflection and Drift Limits: No greater than the following:

a. Purlins and Rafters: Vertical deflection of **1/240** of the span.

b. Girts: Horizontal deflection of **1/180** of the span.

c. Metal Roof Panels: Vertical deflection of**1/240** of the span.

d. Metal Wall Panels: Horizontal deflection of **1/180** of the span.

e. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.

f. Lateral Drift:

1) Maximum of 1/400 of the building height at end wall frames.

2) Maximum of 1/240 of the building height at interior frames.

3) Maximum of 1/400 of the building height out-of-plane of end walls.

4) Maximum of 1/400 of the building height in-plane of side walls.

5) As indicated on Drawings at interface between Metal Building System and conventional steel framed building.

C. Seismic Performance: Metal building system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Fire-Resistance Ratings: Where assemblies are indicated to have a fire-resistance rating, provide metal panel assemblies identical to those of assemblies tested for fire resistance per ASTM E119 or ASTM E108 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

F. Structural Performance for Metal Roof and Wall Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.

2.4 STRUCTURAL-STEEL FRAMING

A. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."

B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

C. 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.

D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, 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 Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.

3. Frame Configuration: As indicated on Drawings.

4. Exterior Column: Tapered.

5. Rafter: Tapered.

E. 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.

F. 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, prepainted with coil coating, to comply with the following:

1. Purlins: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- (64-mm-) wide flanges.

a. Depth: As needed to comply with system performance requirements.

2. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- (64-mm-) wide flanges.

a. Depth: 12 inch.

3. 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.

4. Flange Bracing: Minimum 2-by-2-by-1/8-inch (51-by-51-by-3-mm) structural-steel angles or 1-inch- (25-mm-) diameter, cold-formed structural tubing to stiffen primary-frame flanges.

5. Sag Bracing: Minimum 1-by-1-by-1/8-inch (25-by-25-by-3-mm) structural-steel angles.

6. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch (76-by-51-mm), fabricated from zinc-coated (galvanized) steel sheet.

7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.

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.

G. 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.

1. Type: As indicated.

H. Bracing: Provide adjustable wind bracing using any method as follows:

1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50 (345); or ASTM A529/A529M, Grade 50 (345); minimum 1/2-inch- (13-mm-) diameter steel; threaded full length or threaded a minimum of 6 inches (152 mm) at each end.

2. Cable: ASTM A475, minimum 1/4-inch- (6-mm-) diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.

3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.

4. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

I. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

J. Materials:

1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).

2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).

3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).

4. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B or C, structural tubing.

5. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55 (205 through 380), or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70 (310 through 480); or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80 (170 through 550), or HSLAS, Grades 45 through 70 (310 through 480).

6. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G60 (Z180) coating designation; mill phosphatized.

7. 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 A755/A755M.

a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G90 (Z275) coating designation.

8. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563 (ASTM A563M) carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.

    a. Finish: Plain.

9. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M,Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

    a. Finish: Plain.

10. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490 (Grade A490M), Type 1, heavy-hex steel structural bolts **or** Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

11. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1 hardened carbon-steel washers.

    a. Finish: Plain.

12. Unheaded Anchor Rods: ASTM F1554, Grade 36.

    a. Configuration: Straight.

    b. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.

    c. Plate Washers: ASTM A36/A36M carbon steel.

    d. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.

    e. Finish: Plain.

13. Headed Anchor Rods: ASTM F1554, Grade 36.

    a. Configuration: Straight.

    b. Nuts: ASTM A563 (ASTM A563M) heavy hex carbon steel.

    c. Plate Washers: ASTM A36/A36M carbon steel.

    d. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.

    e. Finish: Plain.

14. Threaded Rods:ASTM A193/A193M or ASTM A572/A572M, Grade **50 (345)**.

a. Nuts: ASTM A563 (ASTM A563M) heavy hex carbon steel.

b. Washers: ASTM F436 (ASTM F436M) hardened.

c. Finish: Plain.

K. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Clean and prepare in accordance with SSPC-SP2.

2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil (0.025 mm).

a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil (0.013 mm) on each side.

2.5 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.

2.6 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 if applicable, or punch for bolts.

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.

2.7 SOURCE QUALITY CONTROL

A. Special Inspection: Owner will engage a qualified special inspector to perform source quality control inspections and to submit reports.

1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.

a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.

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 instructions and 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 and Bearing 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 High-Strength Bolts" for bolt type and joint type specified.

a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

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. 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 and cable bracing 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 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing**,** bearing plates**,** and accessories.

1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."

2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

END OF SECTION 133419

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SECTION 31 20 00 – EARTH MOVING

PART 1 - GENERAL

1.1 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. Division 1 – Unit Prices.
2. Section 015713 – Temporary Erosion and Sediment Control.
3. Section 033000 – Cast-In-Place Concrete.
4. Section 311000 – Site Clearing.
5. Section 331100 - Water Utility Distribution Piping
6. Section 333100 – Sanitary Utility Sewerage Piping
7. Section 334100 – Storm Utility Drainage Piping.
8. Section 334613 – Foundation Drainage.

1.2 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.

1.3 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. Blasting Plan in accordance with Section 1.4B.

E. Reports of blasting and vibration monitoring in accordance with Section 1.4C.

F. Soil testing reports as required by Section 1.4D

1.4 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. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code." Contractor shall hire a blasting consultant to prepare a blasting plan reporting the following:
   1. Types of explosive, blast pattern, hole size, stemming and other details, delay pattern, blast schedule, and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage and settlement to site improvements and structures on Project site and adjacent properties.
   2. Seismographic monitoring during blasting operations.
   3. Safety requirements.
   4. Monitoring criteria, including threshold and limiting peak particle velocity vibration values at existing structures..
   5. Environmental considerations.
   6. Post blast reporting requirements.
   7. Other blasting related issues.
   8. Test-blast program: pre-construction testing of proposed blasting procedures to determine the site-specific attenuation of vibration at all adjacent buildings, including... Adjust procedures as required to avoid damage to existing facilities.
   9. Per owner request, first blast must occur on Monday afternoon between 2pm and 4pm. Contractor to coordinate with owner representative prior to first blast.

C. Seismic Survey Agency: An independent testing agency hired by Contractor, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
   1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
   2. Seismographic monitoring during blasting operations.
   3. Provide certificates showing that all siesmographs have been calibrated by a certified firm within the last 12 months.

D. 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.

E. 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.

1.5 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.

1.6 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

2.1 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. Construction Fill and Backfill

1. Engineered fill is defined as soil or granular fill 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 +4 percent of optimum moisture content as described by ASTM D698. granular fill, such as MoDOT 1007 Type 1 or 5, 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 as soon as borrow sources are identified to determine suitability and conformance with the following recommendations:
   a. Soil classified as MH, OH, OL, or PT (high plasticity soils and organic soils) by the Unified Soil Classification system (ASTM D 2487) shall not be imported for use as engineered fill.
   b. Soils that classify as CH shall be analyzed and approved by a qualified geotechnical engineer prior to use on site.
   c. Soils found during this investigation are acceptable for use as engineered fill, however, material considered undocumented fill found in the southern half of the site shall be approved by a qualified geotechnical engineer prior to being used as engineered fill.
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. Rocks and stones that exceed the thickness of the 8 inch loose lift layer shall be removed and disposed of off the immediate construction site

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 50 percent and a plasticity index less than 30, 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. A granular fill containing sufficient fines to exhibit a definite moisture/density relationship.
   c. Shot Rock: In order to provide a uniform bearing surface and minimize differential settlement, a minimum of two vertical feet of shot material shall be placed and compacted under the entire shallow foundation system and floor slabs. This would require areas to be "overshot" where the design bearing elevation is less than or

equal to top of encountered rock elevation. Excavation within the building footprint shall be overshot to the necessary depth, then reworked as shot rock fill and brought back up to the design bearing elevation(s) using the compaction method described below. Where fill is placed adjacent to or on existing slopes, the slope shall be benched to receive new fill with horizontal benches a maximum of 2 feet high and wide enough to accommodate construction equipment.

1) Compaction**:** Fractured rock and shot rock fills are not amendable to quality assurance testing based on comparison to laboratory standards such as "standard" or "modified" proctors as described in ASTM D698 and D1557, respectively. Quality assurance of these fills is typically based on construction monitoring by a qualified engineer or their representative. Lift thickness of shot rock fill shall not exceed 24 inches. Compaction shall be achieved by a minimum of four complete passes over the fill using a tracked piece of construction equipment with a gross weight exceeding 30,000 pounds and a ground pressure greater than 10 pounds per square inch. Compaction efforts shall be executed in such a matter that the final shot rock fill layer does not contain open voids. It may become necessary to reduce lift thickness, increase the number of passes, or provide vibratory compaction if voids are present.
2) Leveling Course: To provide the most uniform subgrade conditions practical and reduce subgrade drag, provide a leveling course on the surface of the finished shot rock under concrete slabs and footings. A dense graded aggregate base with an approximate 1 inch top size is required as leveling material. Provide a leveling course thickness of 2 inches for shot rock subgrades. The leveling course shall be compacted with a smooth drum vibratory roller.

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: Clean crushed stone or gravel, free of Shale, clay, friable material, and debris, complying with ASTM C33 Size No. 67.

F. Pavement Subbase Course:
1. Definition: Granular base used beneath concrete pavement and other pavements indicated on Drawings.
2. Acceptable materials: Comply with APWA Street Construction and Material Specifications, Division II.

G. Crushed Limestone Fill Material:
1. Definition: That material used at trench backfill under pavements, at locations specified under this Section, and at locations indicated on Drawings.
2. Acceptable materials: Comply with APWA Street Construction and Material Specifications, Division II.

H. Bedding Materials: Type 1 aggregate per MoDOT Standard Specification for Highway Construction, Section 1007.

I. 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.

J. 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.

K. Suitable Soils: Suitable soils within 36 inches of finished grade in lawn and plater areas shall be cohesive soils in Soil Classification Groups ML, CL, CH or a combination thereof, free of rock or gravel greater than one (1) inch in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.

L. 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

3.1 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. 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.

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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 +4 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 +4 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 +4 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 +4 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 +4 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 +4 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.

3.7 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.

3.8 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 +4 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 +4 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 0 and +4 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 0 and +4 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 +4 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 +4 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.

3.9 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 +4 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 +4 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 +4 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 31 66 16 - SOIL NAIL WALL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The work specified in this Section includes the design, furnishing, and installation of permanent earth retention systems shown on the contract drawings for excavations consisting of soil nail and shotcrete wall. In addition, work also includes any temporary soil nail systems required for construction that are required in addition to the permanent system. The design of the temporary soil nail systems shall be part of the contractor's responsibility. The support of excavation system shall be constructed in accordance with this specification and detailed design drawings.

B. All soil nails required for the permanent earth retention system shown on the drawings and shall incorporate Class I corrosion in accordance with PTI

C. Adjacent structures are those that are within a distance equal to twice the total depth of the excavation away from the closest edge of the excavation.

D. Instrumentation to monitor the performance of the earth retention system shall be contractor's responsibility.

1.2 RELATED SPECIFICATIONS

A. Section 31 20 00: Earth Moving

B. Section 03 37 13: Shotcrete

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. Standard Specification for Structural Steel

2. A416: Specification for Uncoated Seven-Wire Stress-Relieved Steel Strand for Prestressed Concrete

3. A615: Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

4. Grout: To be determined

B. American Wood-Preserves Association (AWPA) Standards.

C. American Welding Society (AWS) Code: Dl.1.

D. Federal Standard, FS TT-W-S71: Wood Preservation and Treating Practices.

E. OSHA Standards and Interpretations: Subpart P - Excavations, Trenching, and Shoring.

F. American Concrete Institute (ACI)

1. ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

1.4 SYSTEM DESCRIPTION

A. The earth retention system provided under this Detailed Specification shall include vertical permanent and temporary soil nails and shotcrete wall to allow an open excavation suitable for the construction of the structures, utilities and pipes planned as part of the general contract.

B. The earth retention system shall safely support all earth loads, water loads, equipment loads, foundation loads from adjacent structures and foreseeable surcharge loads.

C. The earth retention system shall be installed such that no movement to adjacent structures occurs during drilling and installing any of of soil nails and shotcrete wall

D. The earth retention system shall allow drainage of groundwater during excavation and temporary construction conditions through the wall without loss of soil.

E. The earth retention system shall allow additional safe excavation as required by the future building contract.

1.5 DESIGN REQUIREMENTS

A. The Contractor shall engage the services of a geotechnical engineer licensed in the state of Missouri to design the permanent earth retention system. The permanent earth retention system shall be designed to safely retain all lateral earth pressures provided by owner's geotechnical engineer, loads from adjacent building and surcharge loads provided on contract documents.

B. The Contractor shall engage the services of a geotechnical engineer to design the temporary earth retention system required for construction. The temporary earth retention system, if required, shall be designed to safely retain all anticipated loads. The temporary soldier piles and bracing shall not interfere with any of the permanent earth retention system.

1.6 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Article 4 of the General Conditions and in applicable provisions of Division 1 – General Requirements, the Contractor shall submit the following:

1. All qualifications as listed below. Include with all job/project references the name of the project and the names, current addresses and telephone numbers, of persons in charge of representing the owner or the owner at the time of excavation.

    a. Earth Retention System Designer's qualifications.

    b. Soil Nail installer's qualifications.

    c. Contractor's independent soil nail testing firm's qualifications.

    d. Earth retention system supervisor's qualifications.

2. List of all applicable laws, regulations, rules, and codes to which earth retention system design conforms.

3. Shop Drawings:

    a. Show proposed permanent earth excavation support system(s), location and extent of differing types of support relative to existing features and structures and the permanent structures to be constructed.

    b. Elevations, sections and profiles showing temporary bracing levels, bearing elevations, maximum excavation levels, and soil nail layout (spacing, angle, lengths, capacity).

    c. Construction details of the permanent and temporary bracing system including materials, sizes, dimensions, connections and methods and sequence of installation and removal.

    d. Monitoring schedule, installation procedures and location plans for geotechnical instrumentation and observation wells, to monitor ground, earth retention, and adjacent structure movements.

4. Complete Calculations to demonstrate that the permanent earth support systems will limit movement to the specified limits and support loads. Calculations shall include, but not limited to, the following:

    a. Narrative description of system.

    b. Design criteria.

    c. Design notes including an explanation of symbols and computer programs used in the design.

    d. Structural design calculation for shotcrete wall facing, including consideration for facing wall flexural and punching shear strength, headed stud tensile strength, upper cantilever, minimum reinforcement ratio, cover.

    e. Other design calculations: Other items may include drainage evaluation and items not considered above.

5. Construction Contingency Plan specifying the methods and procedures to maintain earth retention system stability if tolerable movements are exceeded.

6. Sequence of installation and removal of any temporary earth retention system required in conjunction with excavation, backfilling and concrete placement.

7. Design lateral pressures used.

8. Soil Nail installation:

    a. Description of equipment to be used for Soil nail installation, including grouting, testing and load transfer.

    b. Tabulations of data for each soil nail to include: identification; location; dates of initial drilling, grouting testing, and final lock-off;; ; grouting pressures and any unusual events.

    c. Results of soil nail testing.

1.7 QUALITY ASSURANCE AND QUALIFICATIONS

A. Conform to the requirements of the OSHA Standards and Interpretations: “Subpart P - Excavation, Trenching, and Shoring”.

B. Prepare design, including calculations and drawings, under the direction of a Missouri Registered Professional Engineer.

C. Qualifications of Earth Retention System Designer:

1. Shall be a State of Missouri Registered Professional Engineer specializing in geotechnical construction.

2. Shall have a minimum of ten (10) years’ experience in the design of specific earth retention systems to be used.

3. Shall have completed a minimum of five (5) successful earth retention system projects of equal type, size, and complexity.

D. Earth Retention System Designer shall stamp and sign all earth retention system calculations, details, and drawings.

E. Soil Nail Installer’s Qualifications:

1. Shall have a minimum of three (3) years experience in the installation of tieback systems of similar type and equal complexity as the proposed system.

2. Shall have completed a minimum of three (3) successful soil nail systems of similar type and equal complexity as the proposed system.

F. Work performed in the installation of earth retention systems without the Owner’s Geotechnical Engineer being present will not be accepted. Remove and reinstall such rejected systems, at no additional cost to the City.

G. Employ an independent testing laboratory to test the soil nail system with the following qualifications:

1. Be accredited by the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program.

2. Employ personnel conducting testing who are trained in the methods and procedures to test and monitor soil nail systems of similar type and equal complexity, as the proposed system.

3. Shall have a minimum of five (5) years' experience in testing of soil nail systems of similar type and equal complexity as the proposed system.

4. Shall have successfully tested a minimum of three (3) soil nail systems of similar type and equal complexity as the proposed system.

H. Obtain and comply with all applicable permits, laws, regulations and codes.

I. All welding shall be performed in accordance with AWS Dl.1.

1.8 DELIVERY, STORAGE AND HANDLING

A. Store structural steel and soil nail materials to prevent sagging which would produce permanent deformation. Keep concentrated loads which occur during stacking or lifting below the level which would produce permanent deformation of the material.

1.09 SITE CONDITIONS

A. For boring logs, field and laboratory test results, refer to the Geotechnical Report appended to the Contract Documents.

B. Locations of borings shall be as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide structural steel plates, and accessory steel shapes.

B. Soil Nails:

1. **T40/20 hollow bar with a minimum yield stress of 84.6 ksi**

2. **ASTM A615 all thread bar with a minimum yield stress of 80 ksi**

C. Cement grout materials and admixtures for tieback anchorages: Grout cube strength shall be a minimum 3500 psi at 7 days and 5000 psi at 28 days.

D. Provide concrete in accordance with Detailed Specification 03 30 00 – Cast-in-Place Concrete when used for support of excavation.

E. Provide shotcrete in accordance with specification 03 37 13 Shotcrete.

F. Provide reinforcement in accordance with Detailed Specification 03 20 00 – Concrete Reinforcement

PART 3 - EXECUTION

3.1 GENERAL

A. Carry out program of earth retention in such a manner as to prevent undermining or disturbing foundations of existing structures or of work ongoing or previously completed.

B. Begin no excavation involving earth retention until the earth retention submittal has been accepted by the Engineer.

C. Continuously monitor the performance of the system, including horizontal and vertical movement and groundwater levels. In the event measured wall movements approach or exceed the specified and indicated levels, take immediate steps to arrest further movement by revising procedures, providing supplementary bracing or other measures (Construction Contingency Plan) as required, at no additional cost to the Owner.

D. A monitoring plan, including location of measurement points and the frequency of recording measurements shall be submitted to the Engineer as part of the construction Plan. Monitoring shall begin with a base-line measurement, a minimum of three (3) readings on three different days, recorded no less than 10 calendar days prior to construction of the wall. In addition to monitoring for movement, the condition of the adjacent structure, including cracks and crack widths, before and after construction of the wall, shall be documented by visual inspection, photographs, and/or video. Structures owned by Owner shall be monitored for movement. As soon as the movements measured exceed thresholds established for adjacent structures, the Contractor shall stop construction, notify the Engineer, and take any immediate remedial measures required to prevent damage to the adjacent structures. The Contractor and Earth Retention System Engineer shall then review the current installation procedures. If revisions to the installation procedures are deemed necessary, the Contractor shall submit a revised installation plan for approval by the Engineer before resuming work.

E. Install and read geotechnical instrumentation in accordance with approved shop drawings. Cooperate fully with the Engineer in providing access to instrument locations. Notify the Engineer immediately if any geotechnical instrumentation is damaged. Repair or replace damaged geotechnical instrumentation at the sole option of the Engineer and at no additional cost to the Owner

F. Adoption of the indicated design or approval by the Engineer of the Contractor’s design will in no way relieve the Contractor of responsibility for the successful performance of construction or any method of protection for adjoining property. Contractor shall bear the entire cost and responsibility of correcting any failure, damages, subsidence, upheaval or cave-ins as a result of improper installation, maintenance or design. Contractor shall pay for all claims, costs and damages that arise as a result of the work performed at no additional cost to the City. Protect all existing utilities affected by construction from damage.

G. Expose active utilities by hand, where they lie within work area.

H. Notify utility owners if existing utilities interfere with the earth retention system. Modify the existing utility with the utility owner's permission or have the utility owner make the modifications at no additional cost to Owner.

3.2 SOIL NAIL INSTALLATION

A. Install soil nails in soil in accordance with approved shop drawings.
B. Drill holes for soil nails at maximum spacing of 5' feet oc or as required to engineering analysis and advance to lengths required.
C. Drill equipment shall be suitable for the strata encountered. Drilling may be accomplished by rotary or percussion methods. The method selected shall not cause cavitation or subsidence of the soils in and around the site.
D. Confirm alignment and location of soil nail is within tolerance.
E. The grouting equipment shall include a mixer capable of producing a grout free of lumps and undispersed cement. The grout pump shall be equipped with a pressure gauge to monitor grout pressures. The grouting equipment shall be sized to enable the entire soil nail anchor to be grouted in one continuous operation. Grout shall be screened to removed lumps. The maximum size of the screen openings shall be 0.25 inches. Mixing and storage times shall not cause excessive temperature build up in the grout. The mixer shall be capable of continuously agitating the grout.
F. Soil nails shall be grouted for the total length of the nails as required by engineering analysis and shown on the approved shop drawings.
G. When the grout has attained the minimum compressive strength, load test the soil nails in accordance with section 3.07.

3.3 ALLOWABLE GROUND DEFORMATION

A. Notify the Engineer when the following hazard warning levels are exceeded:

1. Vertical movement (heave/settlement): 1/2 inch.

2. Lateral movement (walls): 1/2 inch.

B. Monitoring personnel shall use a procedure for reading and recording geotechnical instrumentation data which compares the current reading to the last reading during data collection to avoid mis-readings.

C. Plot the observed ground deformation readings versus time. Annotate the plots with construction loading and excavation events having an impact on the readings. Evaluate plots by means of secondary rate-of-change plots to provide early warning of accelerating ground movements.

D. Implement Construction Contingency Plan under direction of the earth retention system designer and Engineer.

3.4 ALLOWABLE VIBRATION

A. Peak particle velocity measured at the nearest structure construction activities that cause noticeable ground vibrations shall not exceed ½ in./sec.

3.5 TESTS AND INSPECTIONS

A. SOIL NAILS:

1. If soil nails are used, perform the number of on-site tests as specified below to demonstrate the performance of tiebacks.

2. Install instruments to monitor the performance of the tieback system.

3. Perform the performance tests described below initially on a minimum of four (4) tiebacks selected by the Engineer for each system design to verify the tieback design. Thereafter perform such performance tests on five (5) percent of all tiebacks installed, as selected by the Engineer. Tiebacks grouted into different soil strata or rock will be considered a different design.

   a. Verification Tests:

      Conduct verification tests by incrementally loading and unloading the soil nail in accordance with the following sequence. At each load increment, record the movement of the end of the soil nail along the axis of the soil nail with a micrometer dial reading to 0.001 inch. A minimum of 5% of all soil nails shall be verification tested, the remainder of the soil nails shall be proof tested in accordance with section 4 below.

Load Increment (% of Design Load)	Hold Period
0.05	1 Min
0.25	10 Min
0.5	10 Min
0.75	10 Min
1.0	10 Min
1.25	10 Min
1.5.	60 Min
1.75	10 Min
2.0	10 Min
2.25	10 Min
2.5	10 Min
2.75	20 Min
3.0	10 Min

4. Perform proof tests on each soil nail not otherwise verification tested by incrementally loading the tieback in accordance with sequence listed below. The creep period shall start as long as the 1.33 test load is applied, and the nail movement shall be measured and recorded at 1, 2, 3, 5, 6, and 10 Minutes. Where the nail movement between 1 minute and 10 minute exceeds 0.04 inches, maintain the maximum test load for an additional 50 minutes, and record movements at 20 min, 30, 50, and 60 minutes. Maintain all load increments within 5% of the intended load.

Load Increment (% of Design Load)	Hold Period
0.05	Until Stabilized
0.25	Until Stabilized
0.5	Until Stabilized

0.75	Until Stabilized
1.0	Until Stabilized
1.25	Until Stabilized
1..33	Creep

5. Criteria for acceptance of soil nails for verification and proof tests will be based on the following:

   a. Rate of movement at 1.33 DL load increment has stabilized to less than 0.004 inches in the last five (5) minutes.

   b. Measured extension at 1.33 DL shall exceed eighty (80) percent of the theoretical elastic elongation of the unbonded length and shall be less than the theoretical elastic elongation of unbonded length plus fifty (50) percent of the bonded length.

   c. The creep amount shall not exceed 0.04 inches at test load during the period of 1 to 10 minutes. If this value is exceeded, then the total creep movement within the period of 6 to 60 minutes shall not exceed 0.08 inches.

6. Perform all testing in the presence of Owner's Geotechnical Engineer. Testing performed without the Engineer present will not be accepted. Repeat testing in the Owner's Geotechnical Engineer's presence at no additional cost.

7. Perform additional tests when any changes are made in the soil nail assembly or installation procedures at no additional cost.

END OF SECTION

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