

**PROJECT MANUAL FOR: Student Recreation Center – AHU 1-3 Replacements**

**PROJECT NUMBER: CP242271**

**AT  
UNIVERSITY OF MISSOURI - Columbia  
Columbia, MISSOURI**

**FOR:**

**THE CURATORS OF THE UNIVERSITY OF MISSOURI**

**PREPARED BY:**

**McClure Engineering, Nick Allen  
1000 Clark Ave.  
St. Louis, MO 63102  
1.314.645.6232**

**DATE: March 15, 2024**

**PROJECT MANUAL FOR: Student Recreation Center – AHU 1-3 Replacement**

**PROJECT NUMBER: CP242271**

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**CERTIFICATION PAGE**

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**Design Professional of Record: Architect**

The Architects seal on these contract documents has been affixed in accordance with the requirements of Chapter 327, RSMO. In affixing this seal, the Architect takes responsibility for the attached architectural specifications. The Architect hereby disclaims any and all responsibility for project specifications other than these, included in these project documents, they being the responsibility of the other design professionals, whose seals and statements appear herein. The following drawings and specifications have been prepared by me or under my direct supervision:

Drawings:	Specifications:
G2.2 SITE / LOGISTICS PLAN	02 4119 SELECTIVE DEMOLITION
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A2.3E NEW WORK SECOND FLOOR PLAN & SOUTHWEST OBSERVATION	07 7200 ROOF ACCESSORIES
A2.4E DEMO & NEW WORK ROOF PLANS	07 8100 APPLIED FIRE PROTECTION
A3.1E BUILDING ELEVATIONS, PLAN & SECTION DETAILS	07 8413 PENETRATION FIRESTOPPING
	07 9200 JOINT SEALANTS
	089200 LOUVERED EQUIPMENT ENCLOSURE
	09 2216 NON-STRUCTURAL METAL FRAMING
	09 2900 GYPSUM BOARD
	09 9123 INTERIOR PAINTING



03/15/2024

**Design Professional Name:**                    **Jennifer Marie Hedrick**  
**State of Missouri License Number:**        **A-7827**

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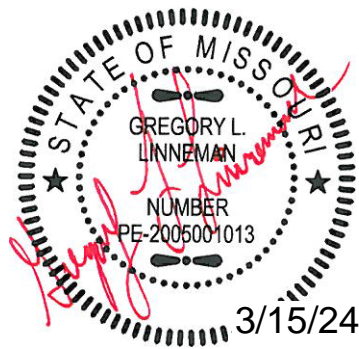
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**Design Professional of Record: Structural Engineer**

The Engineers seal on these contract documents has been affixed in accordance with the requirements of Chapter 327, RSMO. In affixing this seal, the engineer takes responsibility for the attached engineering specifications. The Engineer hereby disclaims any and all responsibility for project specifications other than these, included in these project documents, they being the responsibility of the other design professionals, whose seals and statements appear herein.

The following drawings and specifications have been prepared by me or under my direct supervision:

- |  |                 |
|--|-----------------|
| Drawings:  | Specifications: |
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**Design Professional Name:**  
**State of Missouri License Number:**

**Gregory L. Linneman**  
**P-2005001013**

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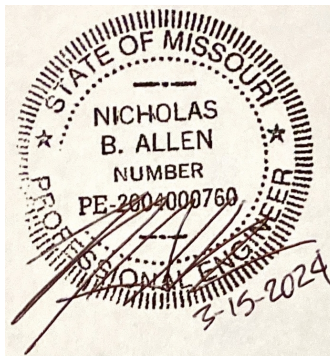
**Design Professional of Record: Mechanical, Electrical, and Plumbing, and Fire Protection Engineer**

The Engineers seal on these contract documents has been affixed in accordance with the requirements of Chapter 327, RSMO. In affixing this seal, the engineer takes responsibility for the attached engineering specifications. The Engineer hereby disclaims any and all responsibility for project specifications other than these, included in these project documents, they being the responsibility of the other design professionals, whose seals and statements appear herein.

The following drawings and specifications have been prepared by me or under my direct supervision:

Drawings:	Specifications:
DM2.0 MECHANICAL ROOM 301 DEMOLITION PLUMBING PLAN	20 0000 BASIC MECHANICAL CONDITIONS
DM3.0 PARTIAL CHILLER ROOM M103 DEMOLITION FLOOR PLAN	21 0000 FIRE PROTECTION SYSTEM
DM3.1 MECHANICAL ROOM 106B DEMOLITION	22 0000 PLUMBING WORK
DM3.2 MECHANICAL ROOM 118 DEMOLITION PLAN	23 0000 HVAC PIPING AND EQUIPMENT
DM3.3 MEZZANINE FLOOR PLAN -EAST	23 0900 CONTROL SYSTEMS
DM3.4 MECHANICAL ROOM 301 DEMOLITION PLAN	24 0000 AIR DISTRIBUTION
DM3.5 MECHANICAL ROOM 301 ROOF DEMOLITION PLAN	
DM5.0 PAU -1/2/3 AIR FLOW DIAGRAM DEMOLITION	
DM5.1 CHILLED AND POOL WATER FLOW DIAGRAM DEMOLITION	
DM5.2 HEATING WATER FLOW DIAGRAM DEMOLITION	
DM5.3 HEATING WATER FLOW DIAGRAM DEMOLITION	
DM5.4 STEAM FLOW DIAGRAM DEMOLITION	
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M1.1 MECHANICAL DETAIL	
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M3.4 MECHANICAL ROOM 301 NEW WORK PLAN	
M3.5 MECHANICAL ROOM 301 ROOF NEW WORK PLAN	

Drawings:	Specifications:
M3.6 SECOND FLOOR SOUTHWEST PLAN M4.0 MECHANICAL DUCTWORK SECTIONS M4.1 MECHANICAL 3D VIEWS M5.0 PAU -1/2/3 AIR FLOW DIAGRAM NEW WORK M5.1 CHILLED AND POOL WATER FLOW DIAGRAM NEW WORK M5.2 HEATING WATER FLOW DIAGRAM NEW WORK M5.3 HEATING WATER FLOW DIAGRAM NEW WORK M5.4 STEAM FLOW DIAGRAM NEW WORK M5.5 ENERGY RECOVERY SYSTEM FLOW DIAGRAM M5.6 PAU-1,2 CONTROLS DIAGRAM M6.0 MECHANICAL SCHEDULES M8.0 MISC. FIRE PROTECTION PLANS	



**Design Professional Name:**  
**State of Missouri License Number:**

**Nick Allen**  
**PE-2004000760**

**CERTIFICATION PAGE**

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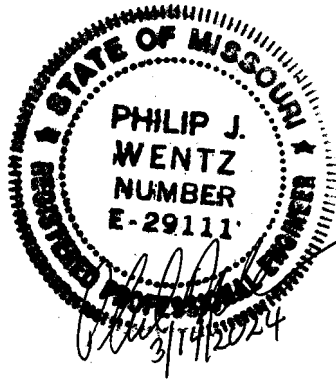
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**Design Professional of Record: Mechanical, Electrical, and Plumbing, and Fire Protection Engineer**

The Engineers seal on these contract documents has been affixed in accordance with the requirements of Chapter 327, RSMO. In affixing this seal, the engineer takes responsibility for the attached engineering specifications. The Engineer hereby disclaims any and all responsibility for project specifications other than these, included in these project documents, they being the responsibility of the other design professionals, whose seals and statements appear herein.

The following drawings and specifications have been prepared by me or under my direct supervision:

Drawings:		Specifications:
E0.0	ELECTRICAL SCHEDULES AND DETAILS	26 0000 ELECTRICAL
E0.1	ELECTRICAL ONE-LINE DIAGRAM - DEMOLITION	
E0.2	ELECTRICAL ONE-LINE DIAGRAM - NEW WORK	
E2.0	MECHANICAL ROOMS - ELECTRICAL DEMOLITION	
E2.1	MECHANICAL ROOM EAST - ELECTRICAL DEMOLITION	
E2.2	MECHANICAL ROOM EAST ROOF - ELECTRICAL DEMOLITION	
E3.0	MECHANICAL ROOMS - ELECTRICAL NEW WORK	
E3.1	MECHANICAL ROOM EAST - ELECTRICAL NEW WORK	
E3.2	MECHANICAL ROOM EAST ROOF - ELECTRICAL NEW WORK	



**Design Professional Name:**                                     Phil J. Wentz  
**State of Missouri License Number:**                        E-29111



PLANNING DESIGN & CONSTRUCTION

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

ADVERTISEMENT FOR BIDS

Sealed bids for:

STUDENT RECREATION CENTER –  
AHU 1-3 REPLACEMENT  
UNIVERSITY OF MISSOURI  
COLUMBIA, MISSOURI  
PROJECT NUMBER: CP242271

CONSTRUCTION ESTIMATE: \$3,235,050-\$3,595,000

will be received by the Curators of the University of Missouri, Owner, at Planning, Design & Construction, Room L100 (Front Reception Desk), General Services Building, University of Missouri, Columbia, Missouri 65211, until 1:30 p.m., C.T., April 18, 2024 and then immediately opened and publicly read aloud.

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

Questions regarding the scope of work should be directed to Sarah Dollar with McClure Engineering at (314) 645-6232 or [sdollar@mclureeng.com](mailto:sdollar@mclureeng.com). Questions regarding commercial conditions should be directed to Heather Brown at (573) 884-6322 or [brownheat@missouri.edu](mailto:brownheat@missouri.edu).

A prebid meeting will be held at 10:00 a.m., C.T., March 28, 2024 in the General Services Bldg., Room 194B, followed by a site walk-through.

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

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

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

Advertisement Date: March 20, 2024

**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 Associate Vice Chancellor – Facilities  
Room L100 General Service Building  
Columbia, MO 65211

1. Bidder, in compliance with invitation for bids for construction work in accordance with Drawings and Specifications prepared by McClure Engineering, entitled "Student Recreation Center – AHU 1-3 Replacement", project number CP242271, dated March 15, 2024, having examined Contract Documents and site of proposed work, and being familiar with all conditions pertaining to construction of proposed project, including availability of materials and labor, hereby proposes to furnish all labor, materials and supplies to construct project in accordance with Contract Documents, within time set forth herein at prices stated below. Prices shall cover all expenses, including taxes not covered by the University of Missouri's tax exemption status, incurred in performing work required under Contract documents, of which this Bid is a part.

Bidder acknowledges receipt of following addenda:

Addendum No. _____	Dated _____
Addendum No. _____	Dated _____
Addendum No. _____	Dated _____
Addendum No. _____	Dated _____

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

3. **BID PRICING**

a. **Base Bid:**

The Bidder agrees to furnish all labor, materials, tools, and equipment required to rebuild pool air handling units 4 & 5; all as indicated on the Drawings and described in these Specifications for sum of:

\_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_).

b. **Additive Alternate Bids (NOT USED):**

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: Replace heating water piping at heat exchanger HX-3:  
The scope of work includes all labor, materials, tools and equipment required to provide new piping to/from heat exchanger HX-3, located in the basement mechanical room, all for sum of:

\_\_\_\_\_ DOLLARS (\$\_\_\_\_\_).

4. PROJECT COMPLETION

a. Contract Period - Contract period begins on the day the Contractor receives unsigned Contract, Performance Bond, Payment Bond, and "Instructions for Execution of Contract, Bonds, and Insurance Certificates." Bidder agrees to complete project within four hundred forty-five (445) calendar days from receipt of aforementioned documents. Fifteen (15) calendar days have been allocated in construction schedule for receiving aforementioned documents from Bidder. Approximately 30 days have been included in the above time to allow the Owner to temporarily delay construction to accommodate competitive events hosted in the facility.

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. Liquidated Damages (not used)

d. Special scheduling requirements (see 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.

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Work to be performed	Subcontractor Name,	City, State
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**HVAC**

---

**Electrical** \_\_\_\_\_

**Plumbing** \_\_\_\_\_

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 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**

**UNIVERSITY OF MISSOURI  
BIDDER'S STATEMENT OF QUALIFICATIONS**

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

1. Company Name \_\_\_\_\_

Phone# \_\_\_\_\_ Fax #: \_\_\_\_\_

Address \_\_\_\_\_

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

\_\_\_\_\_  
\_\_\_\_\_

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

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

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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

\_\_\_\_\_

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

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

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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

\_\_\_\_\_  
\_\_\_\_\_

7. No default has been made in any contract complete or incomplete except as noted below:

(a) Number of contracts on which default was made \_\_\_\_\_

(b) Description of defaulted contracts and reason therefor

\_\_\_\_\_  
\_\_\_\_\_

8. (a) Have you or your company participated in any contract subject to an equal opportunity clause similar to that described in the General Conditions?

Yes \_\_\_\_\_ No \_\_\_\_\_

(b) Have you filed all required compliance reports?

Yes \_\_\_\_\_ No \_\_\_\_\_

- (c) Is fifty percent or more of your company owned by a minority?  
Yes \_\_\_\_\_ No \_\_\_\_\_
- (d) Is fifty percent or more of your company owned by a woman?  
Yes \_\_\_\_\_ No \_\_\_\_\_
- (e) Is fifty percent or more of your company owned by a service disabled veteran?  
Yes \_\_\_\_\_ No \_\_\_\_\_
- (f) Is fifty percent or more of your company owned by a veteran?  
Yes \_\_\_\_\_ No \_\_\_\_\_
- (g) Is your company a Disadvantaged Business Enterprise?  
Yes \_\_\_\_\_ No \_\_\_\_\_

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

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

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11. Workers Compensation Experience Modification Rates (last 3 yrs): \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_  
Incidence Rates (last 3 years): \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

12. List banking references.

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- 13. (a) Do you have a current confidential financial statement on file with Owner?  
Yes \_\_\_\_\_ No \_\_\_\_\_ (If not, and if desired, Bidder may submit such statement with bid, in a separate sealed and labeled envelope.)
- (b) If not, upon request will you file a detailed confidential financial statement within three (3) days?  
Yes \_\_\_\_\_ No \_\_\_\_\_

Dated at \_\_\_\_\_ this \_\_\_\_\_ day of \_\_\_\_\_ 20\_\_\_\_

---

Name of Organization

---

Signature

---

Printed Name

---

Title of Person Signing

END OF SECTION



**SUPPLIER DIVERSITY COMPLIANCE EVALUATION FORM**

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

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

I. Project: \_\_\_\_\_

II. Name of General Contractor: \_\_\_\_\_

III. Name of Diverse Firm: \_\_\_\_\_  
Address: \_\_\_\_\_

Phone No.: \_\_\_\_\_ Fax No.: \_\_\_\_\_

Status (check one) MBE \_\_\_\_\_ WBE \_\_\_\_\_ Veteran \_\_\_\_\_ Service Disabled Veteran \_\_\_\_\_ DBE \_\_\_\_\_

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

V. Dollar amount of contract to be subcontracted to the Diverse firm:  
Base Bid: \_\_\_\_\_

Alternate(s), (Identify separately): \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

VI. Is the proposed subcontractor listed in the Directory of M/W/DBE Vendors, Directory of Serviced Disabled Veterans and/or the Directory of Veterans maintained by the State of Missouri?  
Yes \_\_\_\_\_ No \_\_\_\_\_

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

Yes \_\_\_\_\_

No \_\_\_\_\_

If yes, please provide details and attach a copy of the certification.

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

Yes \_\_\_\_\_

No \_\_\_\_\_

If yes, please attach letter.

Signature:

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Name:

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Title:

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Date:

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**APPLICATION FOR WAIVER**

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

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

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

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

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

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

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

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

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

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

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

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

Signature \_\_\_\_\_

Name \_\_\_\_\_

Title \_\_\_\_\_

Company \_\_\_\_\_

Date \_\_\_\_\_

**AFFIDAVIT**

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

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

Signature \_\_\_\_\_

Name \_\_\_\_\_

Title \_\_\_\_\_

Date \_\_\_\_\_

Corporate Seal (where appropriate)

Date \_\_\_\_\_

State of \_\_\_\_\_

County of \_\_\_\_\_

On this \_\_\_\_\_ day of \_\_\_\_\_, 19\_,  
before me appeared (name) \_\_\_\_\_ to me personally known, who, being  
duly sworn, did execute the foregoing affidavit, and did state that he or she was properly authorized by (name of firm)

\_\_\_\_\_  
\_\_\_\_\_ to execute the affidavit and did so as his or her own free act and deed.

(Seal)

Notary Public \_\_\_\_\_

Commission expires \_\_\_\_\_

**AFFIDAVIT FOR AFFIRMATIVE ACTION**

State of Missouri                    )  
  )  
County of                                )                    ss.

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

\_\_\_\_\_

Subscribed and sworn before me this \_\_\_\_\_ day of \_\_\_\_\_, 19\_\_\_\_\_.

My commission expires \_\_\_\_\_, 19\_\_\_\_\_.

## CERTIFYING SUPPLIER DIVERSITY AGENCIES

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

St. Louis Development Corporation  
1520 Market St., Ste. 2000  
St. Louis, MO 63103  
P: 314.982.1400  
W: [www.stlouis-mo.gov/slcdc/](http://www.stlouis-mo.gov/slcdc/)

Bi-State Development  
211 N. Broadway, Ste. 700  
St. Louis, MO 63102  
P: 314.982.1400  
W: [www.metrostlouis.dbesystem.com](http://www.metrostlouis.dbesystem.com)

St. Louis Minority Business Council  
211 N. Broadway, Ste. 1300  
St. Louis, MO 63102  
P: 314.231.5555  
W: [www.slmbc.org](http://www.slmbc.org)

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

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

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

Mid-States Minority Supplier Development Council  
505 N. 7<sup>th</sup> Street, Ste. 1820  
St. Louis, MO 63101  
P: 314.278.5616  
W: [midstatesdc.org](http://midstatesdc.org)

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

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

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

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

## Minority Newspapers

Dos Mundos Bilingual Newspaper  
902A Southwest Blvd.  
Kansas City, MO 64108  
816-221-4747  
[www.dosmundos.com](http://www.dosmundos.com)

Kansas City Hispanic News  
2918 Southwest Blvd.  
Kansas City, MO 64108  
816/472-5246  
[www.kchispanicnews.com](http://www.kchispanicnews.com)

The Kansas City Globe  
615 E. 29th Street  
Kansas City, MO 64109  
816-531-5253  
[www.thekcglobe.com/about\\_us.php](http://www.thekcglobe.com/about_us.php)

St. Louis American  
4144 Lindell  
St. Louis, MO 63108  
314-533-8000  
[www.stlamerican.com](http://www.stlamerican.com)

St. Louis Chinese American News  
1766 Burns Ave, Suite 201  
St. Louis, MO 63132  
314-432-3858  
[www.scanews.com](http://www.scanews.com)

St. Louis Business Journal  
815 Olive St., Suite 100  
St. Louis, MO 63101  
314-421-6200  
[www.bizjournal.com/stlouis](http://www.bizjournal.com/stlouis)

Kansas City Business Journal  
1100 Main Street, Suite 210  
Kansas City, MO 64105  
816-421-5900  
[www.bizjournals.com/kansascity](http://www.bizjournals.com/kansascity)



## **AFFIDAVIT OF SUPPLIER DIVERSITY PARTICIPATION**

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

1. Diverse Firm: \_\_\_\_\_  
 Contact Name: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 Phone No.: \_\_\_\_\_ E-Mail: \_\_\_\_\_

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

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

Agency: \_\_\_\_\_ [attach copy of certification authorization from agency]

Certification Number: \_\_\_\_\_

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

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

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

General Contractor: \_\_\_\_\_ Diverse Firm: \_\_\_\_\_

Signature: \_\_\_\_\_ Signature: \_\_\_\_\_

Name: \_\_\_\_\_ Name: \_\_\_\_\_

Title: \_\_\_\_\_ Title: \_\_\_\_\_

Date: \_\_\_\_\_ Date: \_\_\_\_\_

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

Contractor: \_\_\_\_\_ Diverse Firm: \_\_\_\_\_

Signature: \_\_\_\_\_ Signature: \_\_\_\_\_

Name: \_\_\_\_\_ Name: \_\_\_\_\_

Title: \_\_\_\_\_ Title: \_\_\_\_\_

Date: \_\_\_\_\_ Date: \_\_\_\_\_

University of Missouri

INFORMATION FOR BIDDERS

Page No.

1. Contract Documents..... FB/1

2. Bidder's Obligation ..... FB/1

3. Interpretation of Documents ..... FB/1

4. Bids ..... FB/1

5. Modification and Withdrawal of Bids..... FB/2

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12. Time of Completion ..... FB/3

13. Number of Contract Documents..... FB/3

14. Missouri Products and Missouri Firms..... FB/3

15. Supplier Diversity ..... FB/3

16. List of Subcontractors ..... FB/5

**1. Contract Documents**

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

**2. Bidder Obligations**

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

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

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

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

**3. Interpretation of Documents**

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

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

**3.3** Bids shall be based only on interpretations issued in the form of addenda mailed to each person who is on the

Architect's record as having received a set of the contract documents.

**4. Bids**

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

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

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

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

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

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

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

## **5. Modification and Withdrawal of Bids**

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

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

## **6. Signing of Bids**

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

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

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

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

## **7. Bid Security**

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

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

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

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

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

## **8. Bidder's Statement of Qualifications**

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

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

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

## **9. Award of Contract**

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

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

## **10. Contract Execution**

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

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

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

#### **11. Contract Security**

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

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

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

#### **12. Time of Completion**

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

#### **13. Number of Contract Documents**

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

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

#### **14. Missouri Products and Missouri Firms**

**14.1** The Curators of the University of Missouri have adopted a policy which is binding upon all employees and departments of the University of Missouri, and which by contract, shall be binding upon independent contractors and subcontractors with the University of Missouri whereby all other things being equal, and when the same can be secured without additional cost over foreign products, or products of other states, a preference shall be granted in all construction, repair and purchase contracts, to all products, commodities,

materials, supplies, and articles mined, grown, produced, and manufactured in marketable quantity and quality in the State of Missouri, and to all firms, corporations or individuals doing business as Missouri firms, corporations, or individuals. Each bidder submitting a bid agrees to comply with and be bound by the foregoing policy.

#### **15. SUPPLIER DIVERSITY**

##### **15.1 Award of Contract**

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

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

##### **15.2 List of Supplier Diversity Firms**

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

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

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

##### **15.3 Supplier Diversity Percentage Goal**

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

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

#### **15.4 Supplier Diversity Percent Goal Computation**

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

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

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

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

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

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

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

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

#### **15.5 Certification by Bidder of Diverse Firms**

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

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

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

#### **15.6 Supplier Diversity Participation Waiver**

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

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

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

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

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

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

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

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

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

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

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

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

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

## **15.7 Submittal of Forms**

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

## **15.8 Additional Bid/Proposer Information**

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

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

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

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

## **16. List of Subcontractors**

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

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

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

University of Missouri

**General Conditions**

of the

**Contract**

for

**Construction**

December 2021 Edition

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**ARTICLE 1  
GENERAL PROVISIONS**

**1.1 Basic Definitions**

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

**1.1.1 Owner**

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

**1.1.2 Contracting Officer**

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

**1.1.3 Owner's Representative**

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

**1.1.4 Architect**

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

**1.1.5 Owner's Authorized Agent**

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

**1.1.6 Contractor**

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

**1.1.7 Subcontractor and Lower-tier Subcontractor**

A Subcontractor is a person or organization who has a contract with the Contractor to perform any of the Work. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or its authorized representative. The term "Subcontractor" also is applicable to those furnishing materials to be incorporated in the Work whether work performed is at the Owner's site or off site, or both. A lower-tier Subcontractor is a person or organization who has a contract with a Subcontractor or another lower-tier

Subcontractor to perform any of the Work at the site. Nothing contained in the Contract Documents shall create contractual relationships between the Owner or the Architect and any Subcontractor or lower-tier Subcontractor of any tier.

**1.1.8 Supplier Diversity Definitions**

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

**.1 Minority Business Enterprises (MBE)**

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

**.1.1** "African Americans", which includes persons having origins in any of the black racial groups of Africa.

**.1.2** "Hispanic Americans", which includes persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race.

**.1.3** "Native Americans", which includes persons of American Indian, Eskimo, Aleut, or Native Hawaiian origin.

**.1.4** "Asian-Pacific Americans", which includes persons whose origins are from Japan, China, Taiwan, Korea, Vietnam, Laos, Cambodia, the Philippines, Samoa, Guam, the U.S. Trust Territories of the Pacific, or the Northern Marianas.

**.1.5** "Asian-Indian Americans", which includes persons whose origins are from India, Pakistan, or Bangladesh.

**.2 Women Business Enterprise (WBE)**

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

**.3 Veteran Owned Business**

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

#### **.4 Service-Disabled Veteran Enterprise (SDVE)**

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

#### **.5 Disadvantaged Business Enterprise (DBE)**

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

U.S. citizens that are African Americans, Hispanics, Native Americans, Asian-Pacific and Subcontinent Asian Americans, and women are presumed to be socially and economically disadvantaged. Also recognized as DBE's are Historically Black Colleges and Universities (HBCU) and small businesses located in Federal HUB Zones.

To be regarded as economically disadvantaged, an individual must have a personal net worth that does not exceed \$1.32 million. To be seen as a small business, a firm must meet Small Business Administration (SBA) size criteria (500 employees or less) and have average annual gross receipts not to exceed \$22.41 million. To be considered a DBE/SDB, a small business owned and controlled by socially and/or economically disadvantaged individuals must receive DBE certification from one of the recognized Missouri state agencies to be recognized in this classification.

#### **1.1.9 Work**

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

#### **1.1.10 Approved**

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

#### **1.1.11 Contract Documents**

The Contract Documents consist of (1) the executed Contract for Construction, (2) these General Conditions of

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

#### **1.1.12 Contract**

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

#### **1.1.13 Change Order**

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

#### **1.1.14 Substantial Completion**

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

#### **1.1.15 Final Completion**

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

#### **1.1.16 Supplemental and Special Conditions**

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

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

#### **1.1.17 Day**

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

#### **1.1.18 Knowledge.**

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

#### **1.1.19 Punch List**

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

#### **1.1.20 Public Works Contracting Minimum Wage**

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

#### **1.1.21 Force Majeure**

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

### **1.2 Specifications and Drawings**

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

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

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

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

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

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

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

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

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

- .1 conditions bearing upon transportation, disposal, handling, and storage of materials;
- .2 the availability of labor, materials, equipment, water, electrical power, utilities and roads;
- .3 uncertainties of weather, river stages, flooding and similar characteristics of the site;
- .4 conditions bearing upon security and protection of material, equipment, and Work in progress;
- .5 the form and nature of the Work site, including the surface and sub-surface conditions;
- .6 the extent and nature of Work and materials necessary for the execution of the Work and the remedying of any defects therein; and
- .7 the means of access to the site and the accommodations it may require and, in general, shall be deemed to have obtained all information as to risks, contingencies and other circumstances.
- .8 the ability to complete work without disruption to normal campus activities, except as specifically allowed in the contract documents.

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

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

### **1.3 Required Provisions Deemed Inserted**

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

## **ARTICLE 2 OWNER**

### **2.1 Information and Services Required of Owner**

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

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

### **2.2 Owner's Right to Stop the Work**

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

### **2.3 Owner's Right to Carry Out the Work**

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

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

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

## **2.4 Extent of Owner Rights**

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

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

## **ARTICLE 3 CONTRACTOR**

### **3.1 Contractor's Warranty**

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

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

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

**3.1.4** Neither the final payment nor any provision in the Contract Documents nor partial or entire occupancy of the premises by the Owner, nor expiration of warranty stated herein, will constitute an acceptance of Work not

done in accordance with the Contract Documents or relieve the Contractor of liability in respect to any responsibility for non-conforming work. The Contractor shall immediately remedy any defects in the Work and pay for any damage to other Work resulting therefrom upon written notice from the Owner. Should the Contractor fail or refuse to remedy the non-conforming work, the Owner may perform, or cause to be performed the work necessary to bring the work into conformance with the Contract Documents at the Contractor's expense.

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

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

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

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

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

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

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

### **3.3 Anti-Kickback**

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

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

### **3.4 Supervision and Construction Procedures**

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

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

**3.4.3** The Contractor and each of its Subcontractors of any tier shall submit to the Owner such schedules of quantities and costs, progress schedules in accordance

with 3.17.2 of this document, payrolls, reports, estimates, records, and other data as the Owner may request concerning Work performed or to be performed under the Contract.

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

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

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

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

- .1** All shutting of valves, switches, etc., shall be by the Owner's personnel.
- .2** Contractor shall submit its preliminary outage/tie-in schedule with its baseline schedule.
- .3** The Contractor shall request an outage/tie-in meeting at least two weeks before the outage/tie-in is required.
- .4** The Owner's Representative will schedule an outage/tie-in meeting at least one week prior to the outage/tie-in.

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



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

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

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

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

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

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

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

**3.4.15** When requested by the Owner's Representative, the Contractor, at no extra charge, shall provide scaffolds

or ladders in place as may be required by the Architect or the Owner for examination or inspection of Work in progress or completed.

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

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

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

### **3.5 Use of Site**

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

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

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

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

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

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

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

### **3.6 Review of Contract Documents and Field Conditions by Contractor**

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

**3.6.2** The Contractor shall take field measurements and verify field conditions and shall carefully compare such field measurements and conditions and other information known to the Contractor with the Contract Documents before commencing activities. Errors, inconsistencies, or omissions discovered shall be reported in writing to the Architect and Owner's Representative within twenty-four (24) hours. During the progress of work, Contractor shall verify all field measurements prior to fabrication of building components or equipment and proceed with the fabrication to meet field conditions. Contractor shall consult all Contract Documents to determine the exact location of all work and verify spatial relationships of all work. Any question concerning said

location or spatial relationships shall be submitted to the Owner's Representative. Specific locations for equipment, pipelines, ductwork and other such items of work, where not dimensioned on plans, shall be determined in consultation with Owner's Representative and Architect. Contractor shall be responsible for the proper fitting of the Work in place.

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

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

### **3.7 Cleaning and Removal**

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

### **3.8 Cutting and Patching**

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

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

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

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

### **3.9 Indemnification**

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

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

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

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

### **3.10 Patents**

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

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

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

### **3.11 Delegated Design**

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

### **3.12 Materials, Labor, and Workmanship**

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

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

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

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

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

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

**3.12.7** Unless otherwise specifically noted, the Contractor shall provide and pay for supervision, labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other

facilities and services necessary for the proper execution and completion of the Work.

### **3.12.8 Substitutions**

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

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

- .1** Full explanation of the proposed substitution and submittal of all supporting data including technical information, catalog cuts, warranties, test results, installation instructions, operating procedures, and other like information necessary for a complete evaluation of the substitution.
- .2** Reasons the substitution is advantageous and necessary, including the benefits to the Owner and the Work in the event the substitution is acceptable.
- .3** The adjustment, if any, in the Contract Sum, in the event the substitution is acceptable.
- .4** The adjustment, if any, in the time of completion of the Contract and the construction schedule in the event the substitution is acceptable.
- .5** An affidavit stating that (a) the proposed substitution conforms to and meets all of the Contract Document requirements and is code compliant, except as specifically disclosed and set forth in the affidavit and (b) the Contractor accepts the warranty and correction obligations in connection with the proposed substitution as if originally specified by the Architect. Proposals for substitutions shall be submitted to the Architect and Owner's Representative in sufficient time to allow the Architect and Owner's Representative no less than ten (10) working days for review. No substitution will be considered or allowed without the Contractor's submittal of complete substantiating data and information as stated herein.

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

- .1** Required for compliance with interpretation of code requirements or insurance regulations then existing;
- .2** Unavailability of specified products, through no fault of the Contractor;
- .3** Material delivered fails to comply with the Contract Documents;
- .4** Subsequent information discloses inability of specified products to perform properly or to fit in designated space;

- .5 Manufacturer/fabricator refuses to certify or guarantee performance of specified product as required; or
- .6 When in the judgment of the Owner or the Architect, a substitution would be substantially to the Owner's best interests, in terms of cost, time, or other considerations.

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

### **3.13 Approved Equal**

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

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

**3.13.3** No approvals or action taken by the Architect or Owner's Representative shall relieve Contractor from its obligation to ensure that an "or equal" article, appliance, device, or material strictly complies with the requirements of the Contract Documents. Contractor shall not propose "or equal" items in connection with Shop Drawings or

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

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

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

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

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

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

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

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

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

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

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

**3.14.9** By approving and submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents such Submittals strictly comply with the requirements of the Contract Documents and that the

Contractor has determined and verified field measurements and field construction criteria related thereto, that materials are fit for their intended use and that the fabrication, shipping, handling, storage, assembly and installation of all materials, systems and equipment are in accordance with best practices in the industry and are in strict compliance with any applicable requirements of the Contract Documents. Contractor shall also coordinate each Submittal with other Submittals.

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

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

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

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

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

### **3.15 Record Drawings**

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

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

### **3.16 Operating Instructions and Service Manuals**

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

- .1** Start-up and Shutdown Procedures: Provide a step-by-step write up of all major equipment. When manufacturer's printed start-up, trouble shooting and shut-down procedures are available, they may be incorporated into the operating manual for reference.
- .2** Operating Instructions: Written operating instructions shall be included for the efficient and safe operation of all equipment.
- .3** Equipment List: List of all major equipment as installed shall include model number, capacities, flow rate, and name-plate data.
- .4** Service Instructions: The Contractor shall be required to provide the following information for all pieces of equipment.
  - (a)** Recommended spare parts including catalog number and name of local suppliers or factory representative.
  - (b)** Belt sizes, types, and lengths.
  - (c)** Wiring diagrams.
- .5** Manufacturer's Certificate of Warranty: Manufacturer's certificates of warranty shall be obtained for all major equipment. Warranty shall be obtained for at least one year from the date of Substantial Completion. Where longer period is required by the Contract Documents, the longer period shall govern.
- .6** Parts catalogs: For each piece of equipment furnished, a parts catalog or similar document shall be provided which identifies the components by number for replacement ordering.

### **3.16.2 Submission**

- .1** Manuals shall be bound into volumes of standard 8 1/2" x 11" hard binders. Large drawings too bulky to be folded into 8 1/2" x 11" shall be separately bound or folded and in brown

envelopes, cross-referenced and indexed with the manuals.

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

### **3.17 Taxes**

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

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

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

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

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

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

### **3.18 Contractor's Construction Schedules**

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

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

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

- .1** The schedule shall be prepared using Primavera P3, Oracle P6, Microsoft Project or other software acceptable to the Owner's Representative.
- .2** The schedule shall be prepared and maintained in CPM format, in accordance with Construction CPM Scheduling, published by the Associated General Contractors of American (AGC).
- .3** Prior to submittal to the Owner's Representative for review, Contractor shall obtain full buy-in to the schedule from all major subcontractors, in writing if so, requested by Owner's Representative.
- .4** Schedule shall be updated, in accordance with Construction CPM Scheduling, published by the AGC, on a monthly basis at minimum, prior to, and submitted with, the monthly pay application or as requested by the Owner's Representative.
- .5** Along with the update the Contractor shall submit a narrative report addressing all changes, delays and impacts, including weather to the schedule

during the last month, and explain how the end date has been impacted by same.

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

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

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

## **ARTICLE 4**

### **ADMINISTRATION OF THE CONTRACT**

#### **4.1 Rights of the Owner**

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

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



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

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

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

**4.1.6** The Owner does not allow smoking on university property.

#### **4.2 Rights of the Architect**

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

#### **4.3 Review of the Work**

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

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

**4.3.3** The fact that the Architect or the Owner's Representative observed, or failed to observe, faulty Work, or Work done which is not in accordance with the Contract Documents, regardless of whether or not the Owner has released final payment, shall not relieve the

Contractor from responsibility for all damages and additional costs of the Owner as a result of defective or faulty Work.

#### **4.4 Claims**

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

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

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

#### **4.5 Claims for Concealed or Unknown Conditions**

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

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

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

#### **4.6 Claim for Additional Cost**

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

#### **4.7 Claims for Additional Time**

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

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

**4.7.2** If weather days are the basis for a Claim for additional time, such Claim shall be documented by the Contractor by data acceptable to the Owner's Representative substantiating that weather conditions for the period of time in question, had an adverse effect on the critical path of the scheduled construction. Weather days shall be defined as days on which critical path work cannot proceed due to weather conditions (including but not limited to rain, snow, etc.), in excess of the number of days shown on the Anticipated Weather Day schedule in the Special Conditions. To be considered a weather day,

at least four working hours must be lost due to the weather conditions on a critical path scope item for that day.-Weather days and Anticipated weather days listed in the Special Conditions shall only apply to Monday through Friday. A weather day claim cannot be made for Saturdays, Sundays, New Year's Day, Martin Luther King Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the day after Thanksgiving Day and Christmas Day, unless that specific day was approved in writing for work by the Owner's Representative.

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

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

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

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

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

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

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

#### **4.8 Resolution of Claims and Disputes**

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

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

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

#### **4.9 Administrative Review**

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

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

appropriate documentation will be signed by the parties to resolve the Claim.

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

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

## **ARTICLE 5 SUBCONTRACTORS**

### **5.1 Award of Subcontracts**

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

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

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

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

## **5.2 Subcontractual Relations**

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

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

forms to be signed by any Subcontractors of any tier or suppliers, Contractor shall obtain the same.

## **5.3 Contingent Assignment of Subcontract**

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

## **ARTICLE 6 SEPARATE CONTRACTS AND COOPERATION**

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

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

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

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

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

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

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

## **ARTICLE 7 CHANGES IN THE WORK**

### **7.1 CHANGE ORDERS**

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

- .1** a change in the Work
- .2** the amount of an adjustment, if any, in the Contract amount
- .3** an adjustment, if any, in the Contract time

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

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

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

- .1** By a lump sum proposal from the Contractor and the Subcontractors of any tier, including overhead and profit.
- .2** By a time and material basis with or without a specified maximum. The Contractor shall submit to the Owner's Representative itemized time and material sheets depicting labor, materials, equipment utilized in completing the Work on a daily basis for the Owner's Representative approval. If this pricing option is utilized, the Contractor may be required to submit weekly reports summarizing costs to

date on time and material change orders not yet finalized.

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

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

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

- .1** Labor: The Contractor's proposal shall include breakdowns by labor, by trade, indicating number of hours and cost per hour for each Subcontractor as applicable. Such breakdowns shall only include employees in the direct employ of Contractor or Subcontractors in the performance of the Work. Such employees shall only include laborers at the site, mechanics, craftsmen and foremen. Payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor or Subcontractors. Any item or expense outside of these categories is not allowed. The expense of performing Work after regular working hours, on Saturdays, Sundays or legal holidays shall not be included in the above, unless approved in writing and in advance by Owner.
- .2** Material, supplies, consumables and equipment to be incorporated into the Work at actual invoice cost to the Contractor or Subcontractors; breakdowns showing all material, installed equipment and consumables fully itemized with number of units installed and cost per unit extended. Any singular item or items in aggregate greater than one thousand dollars (\$1,000) in cost shall be supported with supplier invoices at the request of the Owner's Representative. Normal hand tools are not compensable.
- .3** Equipment: Breakdown for required equipment shall itemize (at a minimum) delivery / pick-up charge, hourly

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

## **7.2 Construction Change Directive**

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

- .1** A lump sum agreement, properly itemized and supported by substantiating documents of sufficient detail to allow evaluation.
- .2** By unit prices contained in the Contractor's original proposal and incorporated in the Construction Contract or subsequently agreed upon.
- .3** A method agreed to by both the Owner and the contractor with a mutually agreeable fee for overhead and profit.
- .4** In the absence of an agreement between the Owner and the Contractor on the method of establishing an adjustment of the contract amount, the Owner, with the assistance of the architect, shall determine the adjustment amount on the basis of expenditures by the Contractor for labor, materials, equipment, and other costs consistent with other provisions of the Contract. The contractor shall keep and submit to the Owner an itemized accounting of all cost components, either expended or saved, while performing the Work covered under the Construction Change Directive.

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

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

## **7.3 Overhead and Profit**

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

- .1** The overhead and profit charged by the Contractor and Subcontractors shall be considered to include, but not limited to, job site office and clerical expense, normal hand tools, incidental job supervision, field supervision, payroll costs and other compensation for project manager, officers, executives, principals, general managers, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, time-keepers, and other personnel employed whether at the site or in principal or a branch office for general superintendent and administration of the Work.
- .2** The percentages for overhead and profit charged on Change Orders shall be negotiated and may vary according to the nature, extent, and complexity of the Work involved but in no case shall exceed the following:
  - 15% To the Contractor or the Subcontractor of any tier for Work performed with their respective forces or materials purchased
  - 5% To the Contractor on Work performed by other than his forces
  - 5% To first tier Subcontractor on Work performed by his Subcontractor
- .3** The Contractor will be allowed to add 2% for the cost of bonding and insurance to their cost of work. This 2% shall be allowed on the total cost of the added work, including overhead and profit.
- .4** Not more than three mark-ups, not to exceed individual maximums shown above, shall be allowed regardless of the number of tier subcontractors. Overhead and profit shall be shown separately for each subcontractor of any tier and the Contractor.
- .5** On proposals covering both increases and decreases in the amount of the Contract, the application of overhead and profit shall be on the net change in direct cost for the Contractor or Subcontractor of any tier performing the Work.
- .6** The percentages for overhead and profit credit to the Owner on Change Orders that are strictly decreases in the quantity of work or materials shall be negotiated and may vary according to the nature, extent, and complexity of the Work involved, but shall not be less than the following:

Overhead and Profit

  - 7.5% Credit to the Owner from the Contractor or Subcontractor of any tier for Work performed with their respective forces or materials purchased
  - 2.5% Credit to the Owner from the Contractor on Work performed by other than his forces
  - 2.5% Credit to the Owner from the first tier Subcontractor on Work performed by his Subcontractor of any tier

## **7.4 Extended General Conditions**

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

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

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

- .1** For the portion of the direct payroll cost of the Contractor's project manager expended in completing the Work and the direct payroll cost of other onsite administrative staff not included in Article 7.3.1. Direct payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor;
- .2** Cost of Contractor's temporary office, including temporary office utilities expense;
- .3** Cost of temporary utilities required in the performance of the work;
- .4** Profit not to exceed 5% of the total extended overhead direct costs;

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

## **7.5 Emergency Work**

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

## **ARTICLE 8 TIME**

### **8.1 Progress and Completion**

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

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

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

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

### **8.2 Delay in Completion**

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

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

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

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

**8.2.4** Notwithstanding anything to the contrary in the Contract Documents, except as otherwise noted in these General Conditions, an extension in the Contract Time, to the extent permitted under this Article, shall be the sole remedy of the Contractor for any (1) delay in the commencement, prosecution or completion of the Work, (2) hindrance or obstruction in the performance of the Work, (3) loss of productivity, or (4) other claims due to or caused by any events beyond the control of both the Owner and Contractor defined herein as Force Majeure. In no event shall the Contractor be entitled to any compensation or recovery of any damages or any portion of damages resulting from delays caused by or within the control of Contractor or by acts or omissions of Contractor or its Subcontractors of any tier or delays beyond the control of both Owner and Contractor. If the Contractor contends that delay, hindrance, obstruction or other adverse condition results from acts or omissions of the Owner, the Owner's Representative or the Architect, Contractor shall provide written notice to the Owner within seven (7) calendar days of the event giving rise to such claim. Contractor shall only be entitled to an adjustment in the Contract Sum to the extent that such acts or omissions continue after the Contractor's written notice to the Owner of such acts or omissions, but in no case shall Force Majeure be the basis of an increase in the Contract sum. The Owner's exercise of any of its rights or remedies under the Contract

Documents (including, without limitation, ordering changes in the Work, or directing suspension, rescheduling or correction of the Work) regardless of the extent or frequency of the Owner's exercise of such rights or remedies, shall not be the basis of any Claim for an increase in the Contract Sum or Contract Time. In the event Contractor is entitled to an adjustment in the Contract Sum for any delay, hindrance, obstruction or other adverse condition caused by the acts or omissions of the Owner, the Owner's Representative or the Architect, Contractor shall only be entitled to its actual direct costs caused thereby and Contractor shall not be entitled to and waives any right to special, indirect, or consequential damages including loss of profits, loss of savings or revenues, loss of anticipated profits, labor inefficiencies, idle equipment, home office overhead, and similar type of damages.

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

### **8.3 Liquidated Damages**

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

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

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

## **ARTICLE 9 PAYMENTS AND COMPLETION**

### **9.1 Commencement, Prosecution, and Completion**

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



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

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

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

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

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

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

**9.1.6** Any successful bidder which is a corporation organized in a state other than Missouri or any bidder doing business in the State of Missouri under a fictitious name shall furnish, at no cost to the Owner, no later than the time at which the executed Contract for Construction, the Payment Bond, and the Performance Bond are returned, a properly certified copy of its current Certificate of Authority and License to do business in the State of Missouri. No contract will be executed by the

Owner until such certificate is furnished by the bidder, unless there already is on file with the Owner a current certificate, in which event, no additional certificate will be required during the period of time for which such current certificate remains in effect.

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

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

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

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

## **9.2 Contract Sum**

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

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

### 9.3 Schedule of Values

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

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

- .1 Enough detail as necessary to adequately evaluate the actual percent complete of any line item on a monthly basis, as determined by the Owner's Representative.
- .2 Line items, when being performed by a subcontractor or material supplier, shall correlate directly back to the subcontract or purchase order amount if requested by the Owner's Representative.

### 9.4 Applications for Payment

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

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

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

**9.4.4** If approved in writing and in advance by Owner, progress payments may be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. Owner may in its sole discretion refuse to grant approval for payments for materials and equipment stored at the Project site but not yet incorporated in the Work. Any approval by Owner for payment for materials and equipment delivered and suitably stored at the site, or stored offsite as noted below,

for subsequent incorporation in the Work shall be conditioned upon Contractor's demonstrating that such materials and equipment are adequately protected from weather, damage, vandalism and theft and that such materials and equipment have been inventoried and stored in accordance with procedures established by or approved by the Owner. Nothing in this clause shall imply or create any liability on the part of the Owner for the Contractor's inventory and storage procedures or for any loss or damage to material, equipment or supplies stored on the site, whether incorporated into the work or not. In the event any such loss or damage occurs, the Contractor remains solely responsible for all costs associated with replacement of the affected materials, supplies and equipment including labor and incidental costs, and shall have no claim against the Owner for such loss.

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

- .1 Items considered to be major items of considerable magnitude, if suitably stored, may be allowed in project pay requests on the basis of ninety percent (90%) of invoices
- .2 Determination of acceptable "major items of considerable magnitude" and "suitably stored" shall be made by the Owner's Representative.
- .3 Aggregate quantities of materials not considered unique to this project will not be considered for offsite storage payment.
- .4 Contractor shall submit to the Owner's Representative a list of the material for which application for payment for offsite storage is anticipated no less than forty-five days prior to the submission of the applicable pay request. The list shall include a material description, applicable division, quantity, and discounts offered to the Owner for early payment. Contractor shall also submit the location the material will be stored and the method of protection
- .5 The storage facility shall be subject to approval by the Owner's representative, shall be located within an acceptable distance of the project sites as established by the Owner's Representative and all materials for the Owner's project must be stored separately from all other items within the storage facility and shall be labeled and stored in the name of The Curators of the University of Missouri.
- .6 The Owner's representative shall be provided a minimum of two weeks' notice to visit the storage facility and inspect the stored material prior to submission of the pay request.
- .7 Upon favorable inspection by the Owner's Representative, the Contractor shall, at the Owner's option, submit a Bill of Sale and Bailment Agreement on forms provided by the Owner's

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

- .8 An invoice provided by the supplier shall be included with the applicable pay request.
- .9 The contractor shall remain fully responsible for all items, until acceptance of the project by the Owner.
- .10 The contractor shall reimburse all costs incurred by the Owner in inspecting and verifying all material stored offsite, including mileage, airfare, meals, lodging and time, charged at a reasonable hourly rate.
- .11 The Contractor shall furnish and maintain insurance covering the replacement cost of the material stored offsite against all losses and shall furnish proof of coverage with the application for payment for material stored offsite.
- .12 The Contractor is responsible for all costs related to storage and handling of material stored offsite unless otherwise directed by the Owner's Representative.

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

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

## **9.5 Approval for Payment**

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

## **9.6 Decisions to Withhold Approval**

**9.6.1** The Owner's Representative may decide not to certify payment and may withhold approval in whole or in part, to the extent reasonably necessary to protect the Owner. If the Owner's Representative is unable to approve payment in the amount of the Application, the Owner's Representative will notify the Contractor as provided in Paragraph 9.5.1. If the Contractor and Owner's Representative cannot agree on a revised amount, the

Owner's Representative will promptly issue approval for payment for the amount for which the Owner's Representative is able to determine is due Contractor. The Owner's Representative may also decide not to approve payment or, because of subsequently discovered evidence or subsequent observations, may nullify the whole or a part of approval for payment previously issued, to such extent as may be necessary in the Owner's Representative opinion to protect the Owner from loss because of:

- .1 defective or non-compliant Work not remedied, or damage to completed Work;
- .2 failure to supply sufficient skilled workers or suitable materials;
- .3 third party claims filed or reasonable evidence indicating probable filing of such claims;
- .4 failure of the Contractor to make payments properly to Subcontractors or for labor, materials or equipment, Owner may, at its sole option issue joint checks to subcontractors who have presented evidence that it has not been paid in accordance with the Contract;
- .5 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- .6 damage to the Owner or another contractor;
- .7 reasonable evidence that the Work will not be completed within the Contract Time or an unsatisfactory rate of progress made by Contractor;
- .8 Contractor's failure to comply with applicable Laws;
- .9 Contractor's or Subcontractor's failure to comply with contract Prevailing Wage requirements; or
- .10 Contractor's failure to carry out the Work in strict accordance with the Contract Documents.

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

## **9.7 Progress Payments**

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

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

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

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

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

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

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

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

## **9.8 Failure of Payment**

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

## **9.9 Substantial Completion**

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

**9.9.2** When the Contractor considers the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall notify the Owner and the Architect. The Owner's

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

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

## **9.10 Partial Occupancy or Use**

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

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

## **9.11 Final Completion and Final Payment**

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

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

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

- .1** Labor costs, prevailing wage rates, fringe benefits and material costs have been paid.
- .2** Subcontractors of any tier and manufacturers furnishing materials and labor for the project have fully completed their Work and have been paid in full.
- .3** The project has been fully completed in accordance with the Contract Documents as modified by Change Orders.
- .4** The acceptance by Contractor of its Final Payment, by check or electronic transfer, shall be and operate as a release of all claims of Contractor against Owner for all things done or furnished or relating to the Work and for every act or alleged neglect of Owner arising out of the Work.

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

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

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

## **ARTICLE 10**

### **PROTECTION OF PERSONS AND PROPERTY**

#### **10.1 Safety Precautions and Programs**

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

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

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

#### **10.2 Safety Of Persons and Property**

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

- .1** students, faculty, staff, the public, construction personnel, and other persons who may be affected thereby;
- .2** the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor or the Contractor's Subcontractors of any tier; and
- .3** other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

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

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

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

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

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

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

**10.2.8** The Contractor shall promptly report in writing to the Owner all accidents arising out of or in connection with

the Work which cause death, lost time injury, personal injury, or property damage, giving full details and statements of any witnesses. In addition, if death, serious personal injuries, or serious property damages are caused, the accident shall be reported immediately.

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

## **ARTICLE 11 INSURANCE & BONDS**

### **11.1 Insurance**

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

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

### **11.2 Commercial General Liability**

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

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

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

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

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

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

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

### **11.3 Licensed for Use Vehicle Liability**

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

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

### **11.4 Workers' Compensation Insurance**

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

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

### **11.5 Liability Insurance General/Other Requirements**

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

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

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

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

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

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

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

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

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

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

**11.5.10** By requiring the insurance set forth herein and in the Contract Documents, Owner does not represent or warrant that coverage and limits will necessarily be adequate to protect Contractor, and such coverages and

limits shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner in the Contract Documents.

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

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

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

## **11.6 Builder's Risk Insurance**

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

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

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

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



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

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

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

- .1 the date which all persons and organization who are insureds under the policy agree in writing that it shall be terminated;
- .2 the date on which final payment of this Contract has been made by Owner to Contractor; or
- .3 the date on which the insurable interests in the property of all insureds other than the Owner have ceased.

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

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

## **11.7 Bonds**

**11.7.1** When the Contract sum exceeds Fifty Thousand Dollars (\$50,000), the Contractor shall procure and

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

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

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

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

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

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

**ARTICLE 12**  
**UNCOVERING AND CORRECTION OF THE**  
**WORK**

**12.1 Uncovering of the Work**

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

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

**12.2 Correction of the Work**

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

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

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

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

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

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

**12.3 Acceptance of Nonconforming Work**

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

**ARTICLE 13**  
**MISCELLANEOUS PROVISIONS**

**13.1 Written Notice**

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

**13.2 Rights and Remedies**

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

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

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

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

**13.3 Tests and Inspections**

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

Architect, the Owner's Representative and/or the Owner's Authorized Agent may observe procedures or perform the necessary tests or inspections.

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

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

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

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

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

**13.4 Nondiscrimination in Employment Equal Opportunity**

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

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

### **13.5 Supplier Diversity Goal Program**

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

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

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

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

**13.5.5** The Contractor and his subcontractors shall develop, implement, maintain, and submit in writing to the Director of Facilities Planning & Development, an affirmative action program if at least fifty (50) persons in the aggregate are employed under this contract. If less than fifty (50) persons in the aggregate are to be employed under this contract, the Contractor shall submit, in lieu of the written affirmative action program, a properly executed "Affidavit for Affirmative Action" in the form as included in the Contract Documents. For the purpose of this section, an "Affirmative Action Program"

means positive actions to influence all employment practices (including, but not limited to, recruiting, hiring, promoting, and training) in providing equal employment opportunity regardless of race, color, sex, national origin, religion, age (where the person affected is between 40 and 70), disabled and Vietnam-era veteran status, and handicapped otherwise qualified status. Such affirmative action program shall include:

- .1 A written policy statement committing the total organization to affirmative action and assigning management responsibilities and procedures for evaluation and dissemination.
- .2 The identification of a person designated to handle affirmative action.
- .3 The establishment of non-discriminatory selection standards, objective measures to analyze recruitment, an upward mobility system, a wage and salary structure, and standards applicable to lay-off, recall, discharge, demotion, and discipline.
- .4 The exclusion of discrimination from collective bargaining agreements.
- .5 Performance of an internal audit of the reporting system to monitor execution and to provide for future planning.

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

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

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

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

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

result in the debarment of the contractor or subcontractor from future work with the University.

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

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

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

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

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

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

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

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

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

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

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

**13.6.13** Time and one-half overtime will be paid on all hours over 10 hours per day or 40 hours per week. The wage rate is the total of the “Basic Hourly Rate” plus “Total Fringe Benefits” or the “public works contracting minimum wage”. For all work performed on a Sunday or

Holiday, not less than twice the prevailing hourly rate of pay or public works contracting minimum wage will apply. Holidays are as follows: January first, the last Monday in May, July fourth, the first Monday in September, November 11, the fourth Thursday in November, December twenty-fifth. If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

### **13.7 Records**

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

### **13.8 Codes and Standards**

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

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

- .16 National Electrical Manufacturers Association (NEMA)
- .17 Underwriter's Laboratories, Inc. (UL), Federal Specifications
- .18 Williams Steiger Occupational Safety and Health Act of 1970 (OSHA)

### **13.9 General Provisions**

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

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

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

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

**13.9.5** Contractor agrees that Owner shall not be liable to Contractor for any special, indirect, incidental, or consequential damage whatsoever, whether caused by

Owner's negligence, fault, errors or omissions, strict liability, breach of contract, breach of warranty or other cause or causes whatsoever. Such special, indirect, incidental or consequential damages include, but are not limited to loss of profits, loss of savings or revenue, loss of anticipated profits, labor inefficiencies, idle equipment, home office overhead, and similar types of damages.

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

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

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

### **13.10 Certification**

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

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

**ARTICLE 14**  
**TERMINATION OR SUSPENSION OF THE**  
**CONTRACT**

**14.1 Termination by Owner for Cause**

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

- .1 refuses or fails to supply enough properly skilled workers, superintendents, foremen, or managers;
- .2 refuses or fails to supply sufficient or proper materials;
- .3 fails to make payment to Subcontractors for materials or labor in accordance with the respective agreements between the Contractor and the Subcontractors;
- .4 disregards laws, ordinances, rules, codes, regulations or orders of an authority having jurisdiction;
- .5 disregards the authority of the Owner's Representative, Architect, or Owner's Authorized Agent;
- .6 breaches any warranty or representations made by the Contractor under or pursuant to the Contract Documents;
- .7 fails to furnish the Owner with assurances satisfactory to the Owner evidencing the Contractor's ability to complete the Work in compliance with all the requirements of the Contract Documents;
- .8 fails after commencement of the Work to proceed continuously with the construction and completion of the Work for more than ten (10) days, except as permitted under the Contract Documents;
- .9 fails to maintain a satisfactory rate of progress with the Work or fails to comply with approved progress schedules; or
- .10 violates in any substantial way any provisions of the Contract Documents.

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

- .1 take possession of the site and of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
- .2 accept assignment of subcontracts pursuant to Paragraph 5.3; and
- .3 finish the Work by whatever reasonable method the Owner may deem expedient, including turning the Work over to the surety.

**14.1.3** The Contractor, in the event of a termination under Section 14.1, shall not be entitled to receive any further payments under the Contract until the Work is completed in its entirety. Then, if the unpaid balance

under the Contract shall exceed all expenses of the Owner in finishing the Work, including additional compensation for the Architects services and expenses made necessary thereby, such excess will be paid to the Contractor; but, if such expenses of Owner to finish the Work shall exceed the unpaid balance, the Contractor and its surety shall be liable for, and shall pay the difference and any damages to the Owner. The obligation of the Contractor and its surety for payment of said amounts shall survive termination of the Contract.

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

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

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

**14.2 Suspension by the Owner for Convenience**

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

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

- .1 that performance is, was, or would have been so suspended, delayed or interrupted by another cause for which the Contractor in whole or in part is responsible, or
- .2 that an equitable adjustment is made or denied under another provision of this Contract.

**14.3 Owner's Termination for Convenience**

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

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



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

- .1 cease operation as specified in the notice;
- .2 place no further orders and enter into no further subcontracts for materials, labor, services or facilities except as necessary to complete Work not terminated;
- .3 terminate all subcontracts and orders to the extent they relate to the Work terminated;
- .4 proceed to complete the performance of Work not terminated; and
- .5 take actions that may be necessary, or that the Owner may direct, for the protection and preservation of the terminated Work.

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

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

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

## 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 "Student Recreation Center – AHU 1-3 Replacement", project number CP242271, and dated March 15, 2024.

b. Architect  
SOA Architecture  
2801 Woodard Drive, Suite 103  
Columbia, MO 65202  
573.443.1407

c. Mechanical & Electrical Engineer  
McClure Engineering  
1000 Clark Avenue  
Saint Louis, Missouri 63102  
314.645,6232

d. Structural Engineer  
Crockett Engineering Consultants  
1000 W. Nifong Blvd., Bldg. 1  
Columbia, Missouri 65203  
573.447.0292

e. Civil Engineer (not applicable)

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

### 2. SPECIAL SCHEDULING REQUIREMENTS

a. Special scheduling requirements supplemental to the bid form:

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

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

(3) Working Hours

- a. Normal working hours are defined as weekdays, 7:00 am to 5:00 pm.
- b. Night Hours are defined as Monday through Thursday after 5:00 pm and before 6:00 am.
- c. Weekend Hours are defined as after 6:00 pm Friday until 4:00 am Monday
- d. Noisy work not allowed during Final Exam weeks. Reference MU academic calendar for Finals weeks in the Fall 2023 semester and the Spring 2024 semester.

(4) Refer to Appendix B – Phasing Narrative, for additional information.

### 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 Replacing AHUs 1, 2, & 3, serving the aquatic center, located in the third floor, east mechanical room of the Student Recreation Center, and associated rooftop work.
  - (2) Demolition shall consist of selective removal of portions of interior ceilings, exterior walls, and roofing assembly to allow for new work.
  - (3) Architectural work shall consist of replacement of interior ceiling and exterior wall assemblies and finishes, after completion of MEP scope. New rooftop stair system and new roofing / patching after installation of new above roof structures supporting new mechanical work.
  - (4) Structural work shall consist of installation of above roof miscellaneous steel framing to support new mechanical equipment and plenums.
  - (5) Mechanical work shall consist of Replacement of PAU-1/2/3 with new. Phase installation to allow the main natatorium room to remain open and active throughout construction. Replace the building steam-to-HW heat exchangers (2) with new. Replace the building heating water pumps (2) with new. Phase installation to limit system downtime. Alternate #1: Replace the heating water piping at heat exchanger HX-3.
  - (6) Plumbing work shall consist of support of the mechanical scope of work.
  - (7) Fire Protection work shall consist of support of the mechanical scope of work.
  - (8) Electrical work shall consist of support of the mechanical scope of work.

### 4. LOCATION

Work shall be performed under this Contract on campus of the University of Missouri - Columbia, at the Student Recreation Center building at 1000 Rollins Street.

### 5. NUMBER OF CONSTRUCTION DOCUMENTS

- a. The Owner's Representative will furnish the Contractor a digital copy of executed Contract and a complete set of Drawings and Specifications in PDF format.
- b. Hard copy prints of any documents (bid or explanatory) will be printed at the Contractor's expense through a printer of their choosing.
- c. The Owner will furnish explanatory and changed Drawings in pdf format to Contractor as issued during project.
- d. The Owner will provide electronic data files to the Contractor for their convenience and use in progressing the Work and the preparation of shop drawings or other submittal

requirements required for construction of the referenced project. The electronic data files shall reflect Construction Documents and Bid Addenda only. These files will be transmitted subject to the following terms and conditions:

- (1) The Owner makes no representation as to the compatibility of these files with the Contractor's hardware or software.
- (2) Data contained on these electronic files shall not be used by the Contractor or anyone else for any purpose other than as a convenience in progressing the Work or in the preparation of shop drawings or other required submittals for the referenced project. Any other use or reuse by the Contractor or by others will be at their own sole risk and without liability or legal exposure to Owner. The Contractor agrees to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against the Owner and its consultants, contractors, agents, employees, and representatives that may arise out of or in connection with the use of the electronic files transmitted.
- (3) Furthermore, the Contractor shall, to the fullest extent permitted by law, indemnify and hold harmless the Owner and its consultants, contractors, agents, employees, and representatives, against all damages, liabilities or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.
- (4) These electronic files are not contract documents. Differences may exist between these electronic files and corresponding hard-copy construction documents. The Owner makes no representation regarding the accuracy or completeness of the electronic files you receive. In the event that a conflict arises between the signed or sealed hard-copy construction documents prepared by the Consultant and the electronic files, the signed and sealed hard-copy construction documents shall govern. The Contractor is responsible for determining if any conflict exists. By use of these electronic files, the Contractor is not relieved of their duty to fully comply with the contract documents.
- (5) Because information presented on the electronic files can be modified, unintentionally or otherwise, the Owner reserves the right to remove all indications of ownership and/or involvement from each electronic display.
- (6) Under no circumstances shall delivery of the electronic files be deemed a sale by the Owner and no warranties are made, either expressed or implied, of merchantability and fitness for any particular purpose. In no event shall the Owner be liable for any loss of profit, or any consequential damages as a result of use or reuse of these electronic files.

## 6. SUBMITTALS

- a. The Contractor shall submit for approval to the Architect, equipment lists and Shop Drawings, as expediently as possible. Failure of the Contractor to submit Shop Drawings in a timely manner will result in the Owner holding back Contractor payments. (See General Conditions)
- b. The material and equipment lists shall be submitted and approved before any material or equipment is purchased and shall be corrected to as-built conditions before the completion of the project.
- c. The Contractor shall submit electronic versions of all required Shop Drawings, material and equipment lists. The Contractor shall upload all Shop Drawings to a secure information sharing website determined by the Owner notifying the Owner and Consultant that these shop drawings are available for review. Each submittal shall have the General Contractors digital stamp affixed to the first page signifying their review and acceptance. Review comments, approvals, and rejections will be posted on this same site with notification to the contractor. Submittals requiring a professional seal shall be submitted hard copy with a manual seal affixed.

- (1) The Contractor shall identify each submittal item with the following:
    - (a) Project Title and Location
    - (b) Project Number
    - (c) Supplier's Name
    - (d) Manufacturer's Name
    - (e) Contract Specification Section and Article Number
    - (f) Contract Drawing Number
    - (g) Acrobat file name: Spec Section\_Times Submitted-Spec Title: 033000\_01-Cast In Place Concrete.pdf
  - (2) Reference the accompanying Shop Drawing and Submittal Log at the end of this section (1.E.3) for required submittal information.
- d. The Contractor shall submit to the Architect four (4) bound copies of all required Operating Instructions and Service Manuals for the Architect's and the Owner's sole use prior to completing 50% of the adjusted contract. Payments beyond 50% of the contract amount may be withheld until all Operating Instructions and Service Manuals are received as referenced in the accompanying Operating Instructions and Service Manual Log at the end of this section (1.E.4).
- e. The Contractor shall submit to the Owner's Representative all items referenced in the accompanying Closeout Log (1.E.5) within 30 days following substantial completion of the work. The Owner's Representative will maintain the closeout log and include as an agenda item at all coordination meetings.

## 7. NOTIFICATION

Before beginning Demolition Work or service outages, the Contractor shall provide, at minimum, seventy-two (72) hours advance notice to Owner's Representative for purpose of verifying utility locations including, but not limited to, gas, telecommunications, electric, water, 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 Drawings and as directed by the Owner's Representative.
- b. Parking:
  - (1) The Owner will issue Contractor two (2) service vehicle parking permits for use in University Virginia Avenue Parking Garage. The permits will be issued at no cost to the contractor up to the contract completion date. After the contract completion date, the permits will be re-issued on an as available basis at the contractors expense. These permits are to be used for general contractor or subcontractor owned and labeled vehicles only. Personal vehicles are prohibited from use of these permits. Violation of this requirement may result in ticketing and/or towing at the vehicle owner's expense and suspension of progress payments.
  - (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: Existing toilet facilities within Project Limits or Restrooms designated by the Owner's Representative for use by the Contractor will be available. Failure of the Contractor to maintain restrooms in a clean condition will be cause for the Contractor's discontinued use of the restroom.
- 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")

There are no known "permit required confined spaces" within the project limits. Each contractor shall conduct a survey to confirm whether or not any confined spaces exist within the project limits. 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"; 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 will not be required as a part of work.
- c. Preserving and Protecting Existing Vegetation:
  - (1) Protection and compensation for damages:
    - (a) Trees and shrubs within work area designated to remain shall be protected from damage during construction by fixed chain link fencing or armoring as indicated on Drawings or specified herein. Plant protection devices shall be installed before work has begun and shall be maintained for duration of work unless otherwise directed by Owner's Representative.
    - (b) In the event that damage(s) to the Owner's trees, shrubs or vegetation occurs as a result of the Contractor's unauthorized operations, the Contractor shall pay or allow to the Owner compensation for said damage(s). Compensation shall be determined by the Owner's Representative using the "Valuation of Landscape Trees, Shrubs, and other Plants" as published by the International Society of Arboriculture, as last revised.
  - (2) 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) Pruning of limbs necessary to repair damage or provide clearance for work shall be done by the MU Landscape Services Department
  - (5) Contractor shall repair tire ruts and other damages to existing lawn areas. Repairs shall match surrounding area.

#### 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 submitted during the bidding period shall be received by both the Architect and the Owner at least ten calendar days prior to the date for receipt of bids. To be considered, bidder's proposal shall include a complete description of the proposed substitution and/or equal and a comparison of significant qualities of the proposed substitution and/or equal with those specified including drawings, performance and test data, and other information necessary for an evaluation. The Architect's decision on the approval or disapproval of a proposed substitution and/or equal shall be final.



- c. If the Architect and Owner approve a proposed substitution prior to receipt of Bids, such approval will be set forth in an Addendum. Bidders shall not rely upon approval made in any other manner.

## 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 (NOT USED)

## 14. PRE-BID INSPECTION

All pre-bid inspections of work areas shall be scheduled with pre-bid inspection guide, telephone: (573) 882-2228.

## 15. ROOF WARRANTY REQUIREMENT

- a. Owner has an existing roof warranty on roof of 9 years remaining and is included at the end of this section. The Contractor shall verify roofing manufacturer and warranty provider. The Contractor shall use a licensed applicator of existing roofing system to make and repair roof penetrations in order for the Owner's existing warranty to remain in full force and effect.

Roof System Manufacturer: Firestone Building Products  
Roof Type: Modified Bitumen (3 ply cold applied modified bitumen,  
polyisocyanurate roof insulation, gypsum recovery board).  
Installer: Watkins Roofing, Inc.  
Manufacturer's Warranty: Twenty (20) years  
Substantial Completion: 08/17/2012  
Expiration Date: 08/17/2032

## 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 (NOT USED)

18. MODIFICATIONS TO GENERAL CONDITIONS (NOT USED)

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.

Contractor Schedule – Contractor is responsible for the schedule and he may provide with in-house personnel or hire a third party scheduling consultant. See Contractor Schedule Specification included in these documents.

20. PROJECT COORDINATION (NOT USED)

21. PROJECT PARTNERING (NOT USED)

22. VALUE ENGINEERING (NOT USED)

23. BUILDING SYSTEM COMMISSIONING

a. Contractor shall provide all personnel and equipment required to complete the commissioning activities referenced in the Commissioning Plan. The requirements of the commissioning plan shall be completed in their entirety before substantial completion and submitted as referenced in the Closeout Log.

b. The contractor shall designate a competent person to act as the contractor's commissioning coordinator. The commissioning coordinator is responsible for planning, scheduling, coordinating, conducting and verifying all commissioning activities required by the commissioning plan and ensuring all building systems are complete, operable and ready for use by the Owner. At a minimum, building ventilation systems, chilled/hot water generation systems, hydronic distribution systems, power distributions systems and fire detection and alarm systems, as applicable.

24. MECHANICAL, ELECTRICAL, PLUMBING (MEP) PRE-INSTALLATION MEETING(S)

a. Before the start of MEP installation, the Owner's Representative will convene an MEP pre-installation meeting. Meeting participants to include contractor (including MEP subcontractors), Owner's Representative and additional contractor and University operational staff invited by the Owner's Representative. Topics will include underground rough-ins, steam piping, chilled water piping, sprinkler piping, hot water piping, electrical system, duct, telephone/data wiring, control wiring. Additional meetings will be conducted as required for the review of coordination drawings and scope specific installations. Cross section drawings of corridor ceilings and other congested areas will be of highest priority and will be reviewed prior to the start of installations in the affected areas. Meeting minutes and sign-up sheet will be transcribed by contractor and distributed to attendees.

25. COST BREAKOUT FOR OWNER'S ACCOUNTING PURPOSES (NOT USED)

26. PROJECT MANAGEMENT/COMMUNICATION REQUIREMENTS

a. The Contractor shall be represented at the site by a 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.

## 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](http://www.cf.missouri.edu/cf/pdc/contractor_information). Copies of all applicable receipts, tickets and tracking logs shall be uploaded to the Owner's information sharing website or reported as required by the Construction Project Manager.

(A summary worksheet is required prior to substantial completion).

## 31. WARRANTY WALKTHROUGH

Contractor shall attend a walk-thru with the Owner at 11 months after acceptance to review and document any warranty items to be addressed as part of the 12 month warranty stated in article 3.1 of the General Conditions.

**END OF SECTION**

# RED SHIELD WARRANTY



## RED SHIELD ROOFING SYSTEM LIMITED WARRANTY

Warranty No: R0051545      FBPCO # CF1558      Square Footage: 53700 s.f.  
Building Owner: CURATORS OF THE UNIVERSITY OF MISSOURI  
Building Identification: STUDENT RECREATION COMPLEX  
Building Address: HITT AND ROLLINS STREETS UNIVE, COLUMBIA, MO. 65201-0000  
Warranty Period Of: TWENTY (20) Years, Beginning On: 08/17/12  
Roofing Contractor: WATKINS ROOFING, INC. (01335)

For the warranty period indicated above, Firestone Building Products Company, LLC ("Firestone"), an Indiana limited liability company, warrants to the Building Owner ("Owner") named above that Firestone will, subject to the Terms, Conditions and Limitations set forth below, repair any leak in the Firestone Roofing System ("System").

### TERMS, CONDITIONS AND LIMITATIONS

- Products Covered.** The System shall mean only the Firestone brand roofing membranes, Firestone brand roofing insulations, Firestone brand roofing metal, and other Firestone brand roofing accessories when installed in accordance with Firestone technical specifications by a Firestone-licensed applicator.
- Notice.** In the event any leak should occur in the System, the Owner must give notice in writing or by telephone to Firestone within thirty (30) days of any occurrence of a leak. Written notice may be sent to Firestone at the street address or fax number shown on the reverse side of this Limited Warranty. Evidence of this notice shall be the receipt by Owner of a Firestone Leak Notification Acknowledgement. By so notifying Firestone, the Owner authorizes Firestone or its designee to investigate the cause of the leak.
- Investigation.** If upon investigation, Firestone determines that the leak is not excluded under the Terms, Conditions and Limitations set forth in this Red Shield Roofing System Limited Warranty (the "Limited Warranty"), the Owner's sole and exclusive remedy and Firestone's total liability shall be limited to the repair of the leak. Should the investigation reveal that the leak is excluded under the Terms, Conditions and Limitations, the Owner shall be responsible for payment of the investigation costs. Failure by Owner to pay for these costs shall render this Limited Warranty null and void. Firestone will advise the Owner of the type and/or extent of repairs required to be made at the Owner's expense that will permit this Limited Warranty to remain in effect for the unexpired portion of its term. Failure by the Owner to properly make these repairs in a reasonable manner using a Firestone-licensed applicator and within 60 days shall render this Limited Warranty null and void.
- No Dollar Limit (NDL).** There is no dollar limit placed on warranted leak repairs to the extent such repairs are covered by this Limited Warranty.
- Disputes.** Any dispute, controversy or claim between the Owner and Firestone concerning this Limited Warranty shall be settled by mediation. In the event that the Owner and Firestone do not resolve the dispute, controversy or claim in mediation, the Owner and Firestone agree that neither party will commence or prosecute any suit, proceeding, or claim other than in the courts of Hamilton County in the state of Indiana or the United States District Court, Southern District of Indiana, Indianapolis Division. Each party irrevocably consents to the jurisdiction and venue of the above-identified courts.
- Payment Required.** Firestone shall have no obligation under this Limited Warranty unless and until Firestone and the licensed applicator have been paid in full for all materials, supplies, services, approved written change orders, warranty costs and other costs which are included in, or incidental to, the System. In the event that repairs not covered by this Limited Warranty are necessary in the future, Firestone reserves the right to suspend this Limited Warranty until such repairs have been completed and the licensed applicator and/or Firestone has been paid in full for such repairs.
- Exclusions.** Firestone shall have no obligation under this Limited Warranty, or any other liability, now or in the future if a leak or damage is caused by:  
(a) Natural forces, disasters, or acts of God including, but not limited to, fires, hurricanes, tornadoes, hail, wind-blown debris, lightning, earthquakes, volcanic activity, atomic radiation, insects or animals; (b) Winds of peak gust speed at or in excess of 55MPH calculated at ten (10) meters above ground using available meteorological data; (c) Act(s), conduct or omission(s) by any person, or act(s) of war, terrorism or vandalism, which damage the System or which impair the System's ability to resist leaks; (d) Failure by the Owner to use reasonable care in maintaining the System, said maintenance to include, but not be limited to, those items listed on the reverse side of this Limited Warranty entitled "Building Envelope Care and Maintenance Guide"; (e) Deterioration or failure of building components, including, but not limited to, the roof substrate, walls, mortar, HVAC units, skylights etc.; (f) Construction generated moisture, condensation or infiltration of moisture in, from, through, or around the walls, copings, rooftop hardware or equipment, skylights, building structure or underlying or surrounding materials; (g) Acid, oil, harmful chemicals, or the reaction between them; (h) Alterations or repairs to the System that are not completed in accordance with Firestone's published specifications, not completed by an approved contractor, and/or not completed with proper notice to Firestone; (i) The design of the roofing system: Firestone does not undertake any analysis of the architecture or engineering required to evaluate what type of System is appropriate for a building and makes no warranty, express or implied as to the suitability of its Products for any particular structure; such a determination is the responsibility of the architect, engineer or design professional; (j) Improper selection of materials for the roof assembly or the failure to accurately calculate wind uplift and/or roof loads; (k) Deterioration to metal roofing materials and accessories caused by marine salt water, atmosphere, or by regular spray of either salt or fresh water; or, (l) Change in building use or purpose.
- Transfer.** This Limited Warranty shall be transferable subject to Owner's payment of the current transfer fee set by Firestone.
- Term.** The term of this Limited Warranty shall be for the period set forth above and such term shall not be extended under any circumstances.
- Roof Access.** During the term of this Limited Warranty, Firestone's designated representative or employees shall have free access to the roof during regular business hours. In the event that roof access is limited due to security or other restrictions, Owner shall reimburse Firestone for all reasonable cost incurred during inspection and/or repair of the System that are due to delays associated with said restrictions. Owner shall be responsible for the damage caused by, removal and replacement of any overburdens, superstrata or overlays, either permanent or temporary, excluding accepted stone ballast or pavers, as necessary to expose the system for inspection and/or repair.
- Waiver.** Firestone's failure to enforce any of the terms or conditions stated herein shall not be construed as a waiver of such provision or of any other terms and conditions of this Limited Warranty.
- Governing Law.** This Limited Warranty shall be governed by and construed in accordance with the laws of the State of Indiana without regard to that State's rules on conflict of laws.
- Severability.** If any portion of this Limited Warranty is held by a court of competent jurisdiction to be invalid, void or unenforceable, the remaining provisions shall nevertheless continue in full force.

FIRESTONE DOES NOT WARRANT PRODUCTS INCORPORATED OR UTILIZED IN THIS INSTALLATION THAT WERE NOT FURNISHED BY FIRESTONE. FIRESTONE SPECIFICALLY DISCLAIMS LIABILITY UNDER ANY THEORY OF LAW ARISING OUT OF THE INSTALLATION OF, PERFORMANCE OF, OR DAMAGES SUSTAINED BY OR CAUSED BY, PRODUCTS NOT FURNISHED BY FIRESTONE.

THIS LIMITED WARRANTY SUPERSEDES AND IS IN LIEU OF ALL OTHER WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND FIRESTONE HEREBY DISCLAIMS ALL SUCH WARRANTIES. THIS LIMITED WARRANTY SHALL BE THE OWNER'S SOLE AND EXCLUSIVE REMEDY AGAINST FIRESTONE, AND FIRESTONE SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, SPECIAL, INCIDENTAL OR OTHER DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS OR DAMAGES TO THE BUILDING OR ITS CONTENTS OR THE ROOF DECK. THIS LIMITED WARRANTY CANNOT BE AMENDED, ALTERED OR MODIFIED IN ANY WAY EXCEPT IN WRITING SIGNED BY AN AUTHORIZED OFFICER OF FIRESTONE. NO OTHER PERSON HAS ANY AUTHORITY TO BIND FIRESTONE WITH ANY REPRESENTATION OR WARRANTY WHETHER ORAL OR WRITTEN.

FIRESTONE BUILDING PRODUCTS COMPANY, LLC

By: Phil LaDuke

Authorized

Signature:

Title:

Director, Quality Assurance

# Firestone

## **BUILDING ENVELOPE CARE AND MAINTENANCE GUIDE (For Red Shield Warranted Roofing Systems)**

**Congratulations** on your purchase of a Firestone Roofing System! Your roof is a valuable asset that should be properly maintained. **All roofs and roofing systems require periodic inspection and maintenance to perform as designed and to keep your Limited Warranty in full force and effect.**

1. The roof should be inspected at least twice yearly and after any severe storms. A record of all inspection and maintenance activities should be maintained, including a listing of the date and time of each activity as well as the identification of the parties performing the activity.
2. Proper maintenance and good roofing practice require that ponded water (defined as water standing on the roof forty-eight hours after it stops raining) not be allowed on the roof. Roofs should have slope to drain, and all drain areas must remain clean. Bag and remove all debris from the roof since such debris can be quickly swept into drains by rain. This will allow for proper water run-off and avoid overloading the roof.
3. The Firestone Roofing System should not be exposed to acids, solvents, greases, oil, fats, chemicals and the like. If the Firestone Roofing System is in contact with any such materials, these contaminants should be removed immediately and any damaged areas should be inspected by a Firestone Licensed Applicator and repaired if necessary.
4. The Firestone Roofing System is designed to be a waterproofing membrane and not a traffic surface. Roof traffic other than periodic traffic to maintain rooftop equipment and conduct periodic inspections should be prohibited. In any areas where periodic roof traffic may be required to service rooftop equipment or to facilitate inspection of the roof, protective walkways should be installed by a Firestone Licensed Applicator as needed to protect the roof surface from damage.
5. Some Firestone roofing membranes require maintenance of the surface of the membrane:
  - a. **Smooth-surfaced Firestone APP membranes** should be coated with an approved liquid coating, such as Firestone Aluminum Roof Coating or Firestone AcryliTop applied in accordance with Firestone specifications, in order to maximize the service life of the membrane. If this coating is not applied as part of the initial roofing installation, it should be applied within the first five years after the roof is installed to help protect the membrane from surface crazing and cracking. In addition, this coating should be maintained as needed to re-coat any areas that have blistered, peeled or worn through.
  - b. **Granule-surfaced Firestone APP and SBS membranes** do not normally require surface maintenance other than periodic inspection for contaminants, cuts or punctures. If areas of granular loss are discovered during inspection, these areas should be coated with Firestone AcryliTop or other Firestone-approved coating applied in accordance with Firestone specifications.
  - c. **Gravel-surfaced Firestone BUR membranes** do not normally require surface maintenance other than periodic inspection for contaminants or damage. If areas of gravel loss are discovered during inspection, gravel must be reinstalled into hot asphalt to protect the surface of the membrane. Coatings on smooth surface BUR membranes must be maintained as needed to re-coat any areas that have blistered, peeled or worn through.
  - d. **Firestone EPDM and TPO roofing membranes** do not normally require surface maintenance other than periodic inspection for contaminants, cuts or punctures. Occasionally, approved liquid roof coatings, such as Firestone AcryliTop, are applied to the surface of EPDM membranes in order to provide a lighter surface color. Such coatings do not need to be maintained to assure the performance of the underlying EPDM roof membrane, but some maintenance and re-coating may be necessary in order to maintain a uniform surface appearance.
  - e. **Firestone Una-Clad metal roofing panels and trim** do not normally require surface maintenance other than periodic inspection for contaminants or damage. In addition, periodic cleaning of the surface may be required to remove dirt and maintain the aesthetic appearance of the coated metal. Simple washing with plain water using hoses or pressure spray equipment is usually adequate. If cleaning with agents other than water is contemplated, several precautions should be observed: (1) do not use wire brushes, abrasives, or similar cleaning tools which will mechanically abrade the coating surface, and (2) cleaning agents should be tested in an inconspicuous area before use on a large scale.
6. All metal work, including counter-flashings, drains, skylights, equipment curbs and supports, and other Firestone brand rooftop accessories must be properly maintained at all times. Particular attention should be paid to sealants at joints in metal work and flashings. If cracking or shrinkage is observed, the joint sealant should be removed and replaced with new sealant.
7. Any alterations to the roof, including but not limited to roof curbs, pipe penetrations, roof-mounted accessories, and tie-ins to building additions must be performed by a licensed Firestone Licensed Applicator and reported to Firestone. Additional information and reporting forms for roof alterations are available at [www.firestonebpco.com](http://www.firestonebpco.com).
8. Should you experience a leak:
  - (a) Check for the obvious: clogged roof drains, loose counterflashings, broken skylights, open grills or vents, broken water pipes.
  - (b) Note conditions resulting in leakage. Heavy or light rain, wind direction, temperature and time of day that the leak occurs are all-important clues to tracing roof leaks. Note whether the leak stops shortly after each rain or continues to drip until the roof is dry. If you are prepared with the facts, the diagnosis and repair of the leak can proceed more rapidly.
  - (c) Contact Firestone Warranty Claims at 1-800-830-5612 as soon as possible...but please don't call until you are reasonably sure that the Firestone Roofing System is the cause of the leak.

Firestone feels that the preceding requirements will assist you, the building owner, in maintaining a watertight roof for many years. Your roof is an investment, and maintenance is essential to maximize your return on this important investment.

**Firestone**  
**BUILDING PRODUCTS**

**NOBODY COVERS YOU BETTER™**

250 West 96th Street – Indianapolis, IN 46260

1-800-428-4442 \* 1-317-575-7000 \* FAX 1-317-575-7100

[www.firestonebp.com](http://www.firestonebp.com)

## Roofing Guarantee

Whereas Watkins Roofing, Inc. of Columbia, MO

herein called "Contractor" has completed application of the following roof:

Owner: Curators of the University of Missouri

Address of Owner: Room L100, General Services Building, UMC Columbia, MO

Type and Name of Building: Student Recreation Complex

Location: Hitt & Rollins St., UMC - Columbia, MO

Area of Roof: 53,700 SF

Date of Completion: 8-17-2012

Date Guarantee Expires: 8-17-2012

Whereas, at the inception of such work, Contractor agreed to guarantee the aforesaid roof for a limited period and subject to the conditions herein set forth;

Now, Therefore, Contractor hereby Guarantees, subject to the conditions herein set forth, that during a period of ~~Two (2)~~ <sup>One (1)</sup> years from the date of completion of said roof, it will, at its own cost and expense, make or cause to be made such repairs to said roof resulting solely from faults or defects in materials or workmanship applied by or through Contractor as may be necessary to maintain said roof in watertight condition.

This guarantee is made subject to the following conditions:

1. Specifically excluded from this guarantee is any and all damage to said roof, the building or contents caused by the acts or omissions of other trades or contractors; lightning, windstorm, hailstorm, flood, earthquake or other unusual phenomena of the elements; foundation settlement; failure or cracking of the roof deck; defects or failure of material used as a roof base over which the roof is applied; faulty construction of parapet walls, copings, chimneys, skylights, vents, supports, or other parts of the building; vapor condensation beneath the roof; penetrations for pitch boxes; water leakage due to erosion and porosity of mortar and brick; dry rot; stoppage of roof drains and gutters; penetration of the roofing from beneath by rising nails; inadequate drainage, slope, or other conditions beyond the control of Contractor which cause ponding or standing of water; termites or other insects; rodents or other animals; or fire. If the roof is damaged by reason of any of the foregoing, this guarantee shall thereupon become null and void for the balance of the guarantee period unless such damage is repaired by Contractor at the expense of the party requesting such repairs.

2. Contractor is not liable for consequential damages to the building or contents resulting from any defects in said roof, including, but without limitation, any interruption of business experienced by Owner or occupants of the building.

3. This guarantee shall become null and void unless the Contractor is promptly notified in writing of any alleged defect in materials or workmanship and provided an opportunity to inspect and, if required by the terms of this Guarantee, to repair the roof.

4. No work shall be done on said roof, including, but without limitation, work in connection with flues, vents, drains, sign braces, railings, platforms or other equipment fastened to or set on the roof, and no repairs or alterations shall be made to said roof, unless Contractor shall first be notified in writing, shall be given the opportunity to make the necessary roofing application recommendations with respect thereto, and such recommendations are complied with. Failure to observe this condition shall render this guarantee null and void. Contractor shall be paid for time and materials expended in making recommendations or repairs occasioned by the work of others on said roof.

5. This guarantee shall become null and void if the roof is used as a promenade or work deck or is sprayed or flooded, unless such use was originally specified and the specification is noted in Paragraph 9, below.

6. This guarantee shall not be or become effective unless and until Contractor has been paid in full for said roof in accordance with the agreement pursuant to which such roof was applied.

7. This guarantee shall accrue only to the benefit of the original Owner named above. It is not transferable to any other person, except with the prior written consent of Contractor.

8. This guarantee is in lieu of all other guarantees or warranties, express or implied. ALL IMPLIED GUARANTEES AND WARRANTIES, AND SPECIFICALLY THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY EXCLUDED AND DISCLAIMED.

9. Additional conditions or exclusions: This Warranty also covers the Joint Sealers for a period of 5 years, beginning on 8/17/2012 and ending on 8/17/2017

IN WITNESS WHEREOF, this instrument has been duly executed this 25 day of Sept., ~~XX~~ <sup>XX</sup> 2012

By \_\_\_\_\_



Approved Guarantee Form No. 1987A, Midwest Roofing Contractors Association, Inc.

Serving Qualified roofing contractors in

Arizona • Arkansas • Colorado • Illinois • Indiana • Iowa • Kansas • Kentucky • Michigan • Minnesota  
Missouri • Montana • Nebraska • New Mexico • North Dakota • Ohio • Oklahoma  
South Dakota • Tennessee • Texas • Utah • Wisconsin • Wyoming

UNIVERSITY OF MISSOURI  
CONTRACTORS ROOFING/FLASHING/SHEET METAL GUARANTEE  
(Revised 12/94)

WHEREAS Watkins Roofing, Inc.  
herein referred to as Roofing Contractor, certify that they have furnished and installed all roofing, flashing, sheet metal and related components in accordance with the Contract Documents and as required by the Roofing System Manufacturer's installation instructions on the facility described below:

Facility: Student Recreation Complex

Owner: Curators of the University of Missouri  
c/o Associate Vice Chancellor – Facilities  
Room L100, General Services Building  
University of Missouri  
Columbia, Missouri 65211

Date of Full Completion: August 17, 2012

Approximate Area of Roof: 53,700 SF

Type of Roofing Material: Fully-Adhered 60 mil EPDM

Manufacturer's Specification Number: .060" LS-FR

Thickness and Type of Roof Insulation: 1" with 1/4" Dens Deck / Tapered ISO

NOW, THEREFORE, Roofing Contractor guarantees to the Owner, subject only to the exclusions stated hereinafter, that all roofing, flashing and sheetmetal work is fully and integrally watertight and is free from faults and defects in material or workmanship, and is guaranteed for a period of three (3) years from date of full completion of work.

EXCLUSIONS: This guarantee does not cover, and Roofing Contractor shall not be liable for the following:

1. Damage to the roofing system caused by fire, lightning, tornado, hurricane or hailstorm.
2. Damage to roofing system caused by significant settlement, distortion or failure of roof deck, walls, or foundations of building, excepting normal building expansion and contraction is not a part of this exclusion.
3. Abuse by the Owner and/or third parties.

REPAIRS: Owner shall promptly notify Roofing Contractor, in writing, of the need for repair of roofing, flashing, or sheet metal:



1. Roofing Contractor, within eight (8) hours after receipt of such notice, shall make emergency repairs at its expense, as required to render the facility watertight.
2. Within five (5) days after receipt of such notice, Roofing Contractor shall at its expense correct any faults or defects in material or workmanship.
3. Should needed repairs not be covered by this guarantee, Roofing Contractor, after having obtained Owner's written consent, shall make such repairs at Owner's expense. Following said repairs, this guarantee shall thereafter remain in effect for the unexpired portion of the original term. If Owner does not so consent or repairs are made by others than the Roofing Contractor, this guarantee shall terminate for those parts of the roof affected by the repair.
4. In the event that Owner has notified the Roofing Contractor of the need for repairs and (i) Roofing Contractor does not immediately make repairs, or (ii) Roofing Contractor disclaims responsibility for the repairs and Owner disagrees, or (iii) Owner considers Roofing Contractor's quoted cost for repairs not covered by this guarantee to be unreasonable and, an emergency condition exists which requires prompt repair to avoid substantial damage or loss to Owner, then, Owner may make such temporary repairs as he finds necessary and such action shall not be a breach of the provisions of this guarantee.

ANNUAL INSPECTIONS: Roofing Contractor shall inspect roof installation prior to each of the three anniversary dates from date of full completion of the work.

1. Inspection team to include Roofing Contractor, Roof Manufacturer, and Owner's Representative.
2. Inspection of total roof system will be included in the annual inspections.
3. All defects in total roof system will be corrected by the Roofing Contractor within 30 days of inspection.
4. Roof manufacturer will certify by a written report that roof inspection has been completed, defects are acknowledged, and will warrant any repairs.
5. All corrective work completed by Roofing Contractor shall be warranted as approved by the Roofing Manufacturer.

ROOF MODIFICATION: Should Owner require work to be done on roof of said facility including modifications, alternations, extensions or additions to roof and including installation of vents, platforms, equipment, bracings or fastenings, Owner shall notify Roofing Contractor and give Roofing Contractor an opportunity to make recommendations as to methods necessary to safeguard against damage to roofing covered by this guarantee. Failure of Owner to give Roofing Contractor such opportunity or failure to follow methods recommended by Roofing Contractor shall render this guarantee null and void to the extent such failure should result in damage to roofing covered by this guarantee.

NOTICES: Notification of Roofing Contractor by Owner, shall be fulfilled by sending notice to Roofing Contractor.

IN WITNESS WHEREOF, we set our hands this 9 day of 26, 2012.

By: [Signature]

Title: President

For Roofing Contractor

Name: Watkins Roofing, Inc.

Address: 4401 I-70 Drive SE, Columbia, MO 65201

Phone: 573-449-2951

July 18, 2012

Universe Corporation  
3333 Foerster Road  
St. Louis, MO 63044

RE: UnivMO-Columbia Student Recreation  
Columbia, MO  
Kalwall #123273-TB

Gentlemen:

We hereby guarantee all properly maintained materials supplied by Kalwall Corporation in accordance with approved shop drawings #K12-3273 at the above referenced project to be free from defects in material and workmanship for a period of five years. Further, we warrant the panels against:

- A. Delamination affecting structural strength
- B. Noticeable surface fiber exposure of the exterior face
- C. Color change in excess of 8 Delta E units caused by normal weathering

for an additional five years. Should the panels fail to meet this portion of the warranty, the liability of the company is limited, at its option, to repair or replacement of the panels, pro rata after five years. We also warrant that there shall be no external exposure of the reinforcing glass fibers for a period of twenty years, pro rata.

Claims must be in writing. Proof of purchase is required. Keep dated invoices. This warranty is valid only after receipt of payment in full and in no event shall this warranty be honored after August 1, 2032. Acts of God, vandals, accidents, improper storage or installation, and substructure movement are not covered by this warranty.

Very truly yours,

KALWALL CORPORATION



Richard R. Keller  
President

RRK/dl

## SECTION 1.E.1 SCHEDULING SPECIFICATION

### 1. GENERAL

- a) Time is of the essence for this contract.  
The time frames spelled out in this contract are essential to the success of this project. The University understands that effective schedule management, in accordance with the General Conditions and these Special Conditions is necessary to insure to that the critical milestone and end dates spelled out in the contract are achieved.
- b) Related Documents  
Drawings and general provisions of the Contract, including General Conditions' Article 3.17 shall apply to this Section.
- c) Stakeholders  
A Stakeholder is anyone with a stake in the outcome of the Project, including the University, the University Department utilizing the facility, the Design Professionals, the Contractor and subcontractors.
- d) Weather
- (1) Contractor acknowledges that there will be days in which work cannot be completed due to the weather, and that a certain number of these lost days are to be expected under normal weather conditions in Missouri.
  - (2) Rather than speculate as to what comprises "normal" weather at the location of the project, Contractor agrees that it will assume a total of 44 lost days due to weather over the course of a calendar year, and include same in its as planned schedule. For projects of less than a calendar year, lost weather days should be prorated for the months of construction in accordance with the following schedule.
  - (3) Anticipated weather days for allocation/proration only. For projects lasting 12 months or longer, the 44 days per year plus whatever additional months are included will constitute normal weather.

Jan – 5 days	Feb – 5 days	Mar – 4 days	Apr – 4 days
May – 3 days	Jun – 3 days	Jul – 2 days	Aug – 2 days
Sep – 3 days	Oct – 4 days	Nov – 4 days	Dec – 5 days

### 2. SCHEDULING PROCESS

- a) The intent of this section is to insure that a well-conceived plan, that addresses the milestone and completion dates spelled out in these documents, is developed with input from all stakeholders in the project. Input is limited to all reasonable requests that are consistent with the requirements of the contract documents, and do not prejudice the Contractor's ability to perform its work consistent with the contract documents.  
Further, the plan must be documented in an understandable format that allows for each stakeholder in the project to understand the plan for the construction and/or renovation contained in the Project.
- b) Contractor Requirements
- (1) Schedule Development  
Contractor shall prepare the Project Schedule using Primavera P3 or Oracle P6.
  - (2) Schedule Development  
Within 4 weeks of the NTP, contractor shall prepare a schedule, in CPM format, that reflects the contractor's and each subcontractors plan for performing the contract work.  
  
Contractor shall review each major subcontractor's schedule with the sub and obtain the subcontractor's concurrence with the schedule, prior to submitting to the University.
  - (3) Schedule Updates.
    - (a) Schedule Updates will be conducted once a month, at a minimum.  
Actual Start and Finish dates should be recorded regularly during the month. Percent

Complete, or Remaining Duration shall be updated as of the data date, just prior to Contractor's submittal of the update data.

- (b) Contractor will copy the previous months schedule and will input update information into the new monthly update version.
- (c) Contractor will meet with the Owner's Representative to review the draft of the updated schedule. At this meeting, Owner's Representative and Contractor will:
  - (i) Review out of sequence progress, making adjustments as necessary,
  - (ii) Add any fragnets necessary to describe changes or other impacts to the project schedule and
  - (iii) Review the resultant critical and near critical paths to determine any impact of the occurrences encountered over the last month.
- (4) Schedule Narrative  
After finalization of the update, the Contractor will prepare a Narrative that describes progress for the month, impacts to the schedule and an assessment as to the Contractor's entitlement to a time extension for occurrences beyond its control during the month and submit in accordance with this Section.
- (5) Progress Meetings
  - (a) Review the updated schedule at each monthly progress meeting. Payments to the Contractor may be suspended if the progress schedule is not adequately updated to reflect actual conditions.
  - (b) Submit progress schedules to subcontractors to permit coordinating their progress schedules to the general construction work. Include 4 week look ahead schedules to allow subs to focus on critical upcoming work.

### 3. CRITICAL PATH METHOD (CPM)

- a) This Section includes administrative and procedural requirements for the critical path method (CPM) of scheduling and reporting progress of the Work.
- b) Refer to the General and Special Conditions and the Agreement for definitions and specific dates of Contract Time.
- c) Critical Path Method (CPM): A method of planning and scheduling a construction project where activities are arranged based on activity relationships and network calculations determine when activities can be performed and the critical path of the Project.
- d) Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall project duration.
- e) Network Diagram: A graphic diagram of a network schedule, showing the activities and activity relationships.
- f) Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling, the construction project. Activities included in a construction schedule consume time and resources.
- g) Critical activities are activities on the critical path.
- h) Predecessor activity is an activity that must be completed before a given activity can be started.
- i) Milestone: A key or critical point in time for reference or measurement.
- j) Float or Slack Time: The measure of leeway in activity performance. Accumulative float time is not for the exclusive use or benefit of the Owner or Contractor, but is a project resource available to both parties as needed to meet contract milestones and the completion date.
- k) Total float is herein defined as the measure of leeway in starting or completing an activity without adversely affecting the planned project completion date.
- l) Weather: Adverse weather that is normal for the area must be taken into account in the Contractor's Project Schedule. See 1.d.3, above.
- m) Force Majeure Event: Any event that delays the project but is beyond the control and/or contractual responsibility of either party.
- n) Schedule shall including the following, in addition to Contractor's work.
  - (1) Phasing: Provide notations on the schedule to show how the sequence of the Work is affected by the following:

- (a) Requirements for phased completion and milestone dates.
- (b) Work by separate contractors.
- (c) Work by the Owner.
- (d) Coordination with existing construction.
- (e) Limitations of continued occupancies.
- (f) Uninterruptible services.
- (g) Partial occupancy prior to Substantial Completion.
- (h) Area Separations: Use Activity Codes to identify each major area of construction for each major portion of the Work. For the purposes of this Article, a "major area" is a story of construction, a separate building, or a similar significant construction element.

#### 4. TIME EXTENSION REQUESTS

- a) Refer to General Conditions of the Contract for Construction, Article 4.7 Claims for Additional Time.
- b) Changes or Other Impacts to the Contractor's Work Plan  
The Owner will consider and evaluate requests for time extensions due to changes or other events beyond the control of the Contractor on a monthly basis only, with the submission of the Contractor's updated schedule, in conjunction with the monthly application for payment. The Update must include:
  - (1) An activity depicting the event(s) impacting the Contractors work plan shall be added to the CPM schedule, using the actual start date of the impact, along with actually required predecessors and successors.
  - (2) After the addition of the impact activity(ies), the Contractor will identify subsequent activities on the critical path, with finish to start relationships that can be realistically adjusted to overlap using good, standard construction practice.
    - (a) If the adjustments above result in the completion date being brought back within the contract time period, no adjustment will be made in the contract time.
    - (b) If the adjustments above still result in a completion date beyond the contract completion date, the delay shall be deemed excusable and the contract completion date shall be extended by the number of days indicated by the analysis.
    - (c) Contractor agrees to continue to utilize its best efforts to make up the time caused by the delays. However the Contractor is not expected to expend costs not contemplated in its contract, in making those efforts.
- c) Questions of compensability of any delays shall be held until the actual completion of the project. If the actual substantial completion date of the project based on excusable delays, excluding weather delays, exceeds the original contract completion date, AND there are no delays that are the responsibility of the contractor to consider, the delays days shall be considered compensable. The actual costs, if any, of the Contractor's time sensitive jobsite supervision and general conditions costs, shall be quantified and a change order issued for these costs.

UNIVERSITY OF MISSOURI  
ROOF SYSTEM MANUFACTURERS CERTIFICATION  
(Revised 12/94)

TO: \_\_\_\_\_ Title \_\_\_\_\_  
Project No. \_\_\_\_\_  
Location \_\_\_\_\_

Our technical staff has examined the Architect/Engineer's Drawings, Specifications and required warranty for the roofing work on this project. We do not wholly endorse the building design or any materials or services not part of our advertised roofing system.

CERTIFICATION

We hereby certify that:

1. All materials we will furnish and deliver to the project shall be of good merchantable quality, shall meet or exceed the Specifications required and shall, if properly applied by one of our approved roofing applicator firms in accord with our instructions, provide a sound weather/watertight roofing system.
2. Upon completion of the installation in accord with the Drawings and specifications and our recommended installation procedures, we shall issue a total system warranty specified in the project Specifications.
3. The Drawings and Specifications follow the recommendations of our roofing manual for this type of roofing system with:

No exceptions.

The following exceptions: (The roofing system will be approved for this project if the following changes are made to the Contract Documents. The bid provided with this Document includes the required changes).

NOTE: Exceptions may cause Owner to reject bid.  
Exceptions are as follows:

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4. The Warranty will be issued for the following proposed roofing system:

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ROOFING SYSTEM MANUFACTURER: \_\_\_\_\_

Authorized Signature: \_\_\_\_\_

Title: \_\_\_\_\_ Date \_\_\_\_\_

Telephone Number: ( ) \_\_\_\_\_

Fax Number: ( ) \_\_\_\_\_

**UNIVERSITY OF MISSOURI  
CONTRACTORS ROOFING/FLASHING/SHEET METAL GUARANTEE  
(Revised 12/94)**

WHEREAS (NAME AND ADDRESS OF COMPANY) \_\_\_\_\_

herein referred to as Roofing Contractor, certify that they have furnished and installed all roofing, flashing, sheet metal and related components in accordance with the Contract Documents and as required by the Roofing System Manufacturer's installation instructions on the facility described below:

Facility: \_\_\_\_\_

Owner: University of Missouri-(CAMPUS)  
(CAMPUS ADDRESS)

Date of Full Completion: \_\_\_\_\_

Approximate Area of Roof: \_\_\_\_\_

Type of Roofing Material: \_\_\_\_\_

Manufacturer's Specification Number: \_\_\_\_\_

Thickness and Type of Roof Insulation: \_\_\_\_\_

NOW, THEREFORE, Roofing Contractor guaranties to the Owner, subject only to the exclusions stated hereinafter, that all roofing, flashing and sheetmetal work is fully and integrally watertight and is free from faults and defects in material or workmanship, and is guaranteed for a period of three (3) years from date of full completion of work.

EXCLUSIONS: This guarantee does not cover, and Roofing Contractor shall not be liable for the following:

1. Damage to the roofing system caused by fire, lightning, tornado, hurricane or hailstorm.
2. Damage to roofing system caused by significant settlement, distortion or failure of roof deck, walls, or foundations of building, excepting normal building expansion and contraction is not a part of this exclusion.
3. Abuse by the Owner and/or third parties.

REPAIRS: Owner shall promptly notify Roofing Contractor, in writing, of the need for repair of roofing, flashing, or sheet metal:

1. Roofing Contractor, within eight (8) hours after receipt of such notice, shall make emergency repairs at its expense, as required to render the facility watertight.
2. Within five (5) days after receipt of such notice, Roofing Contractor shall at its expense correct any faults or defects in material or workmanship.
3. Should needed repairs not be covered by this guarantee, Roofing Contractor, after having obtained Owner's written consent, shall make such repairs at Owner's expense. Following said repairs, this guarantee shall thereafter remain in effect for the unexpired portion of the original term. If Owner does not so consent or repairs are made by others than the Roofing Contractor, this guarantee



shall terminate for those parts of the roof affected by the repair.

4. In the event that Owner has notified the Roofing Contractor of the need for repairs and (i) Roofing Contractor does not immediately make repairs, or (ii) Roofing Contractor disclaims responsibility for the repairs and Owner disagrees, or (iii) Owner considers Roofing Contractor=s quoted cost for repairs not covered by this guarantee to be unreasonable and, an emergency condition exists which requires prompt repair to avoid substantial damage or loss to Owner, then, Owner may make such temporary repairs as he finds necessary and such action shall not be a breach of the provisions of this guarantee.

ANNUAL INSPECTIONS: Roofing Contractor shall inspect roof installation prior to each of the three anniversary dates from date of full completion of the work.

1. Inspection team to include Roofing Contractor, Roof Manufacturer, and Owner=s Representative.
2. Inspection of total roof system will be included in the annual inspections.
3. All defects in total roof system will be corrected by the Roofing Contractor within 30 days of inspection.
4. Roof manufacturer will certify by a written report that roof inspection has been completed, defects are acknowledged, and will warrant any repairs.
5. All corrective work completed by Roofing Contractor shall be warranted as approved by the Roofing Manufacturer.

ROOF MODIFICATION: Should Owner require work to be done on roof of said facility including modifications, alternations, extensions or additions to roof and including installation of vents, platforms, equipment, bracings or fastenings, Owner shall notify Roofing Contractor and give Roofing Contractor an opportunity to make recommendations as to methods necessary to safeguard against damage to roofing covered by this guarantee. Failure of Owner to give Roofing Contractor such opportunity or failure to follow methods recommended by Roofing Contractor shall render this guarantee null and void to the extent such failure should result in damage to roofing covered by this guarantee.

NOTICES: Notification of Roofing Contractor by Owner, shall be fulfilled by sending notice to Roofing Contractor.

IN WITNESS WHEREOF, we set our hands this \_\_\_\_ day of \_\_\_\_\_, 20\_\_.

By:\_\_\_\_\_

Title:\_\_\_\_\_


For Roofing Contractor

Name:\_\_\_\_\_


Address:\_\_\_\_\_

Phone:\_\_\_\_\_

SHOP DRAWING AND SUBMITTAL LOG

DATE REC'D	SUBMITTAL #	SPEC. SECTION #	 SPEC / SUBMITTAL DESCRIPTION	SUBCONTRACTOR	MUHC TO REVIEW	REFERRED				ACTION				COPIES TO			
						TO	SOA Transmittal No.	Date sent to Consultant	# COPIES	Date Rec'd from consultant	APPROVED	APPROVED AS CORRECTED	REVISE & RESUBMIT	REJECTED	SUBMIT SPECIFIC ITEM	Date Ret'd to General Contractor	SOA Transmittal No.
<b>ARCHITECTURAL / STRUCTURAL</b>																	
	03 0000		<b>CAST-IN-PLACE CONCRETE</b>														
			Concrete Mix Design														
	05 0000		<b>STRUCTURAL STEEL</b>														
			Shop drawings														
	05 4000		<b>COLD-FORMED METAL FRAMING</b>														
			Product Data														
	07 5216		<b>STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING</b>														
			Product Data														
			Shop drawings														
	07 6200		<b>SHEET METAL FLASHING AND TRIM</b>														
			Product Data														
	07 7200		<b>ROOF ACCESSORIES</b>														
			Product Data														
			Shop drawings														
	07 8413		<b>PENETRATION FIRESTOPPING</b>														
			Product Data														
			Product Schedule														
	07 9200		<b>JOINT SEALANTS</b>														
			Product Data														
			Samples for Verification														
			Joint Sealant Schedule														
	09 2216		<b>NON-STRUCTURAL METAL FRAMING</b>														
			Product Data														
	09 9200		<b>GYPSUM BOARD</b>														
			Product Data														
	09 9123		<b>INTERIOR PAINTING</b>														
			Product Data														
			Samples for Verification														
			Product List														
<b>MECHANICAL / ELECTRICAL</b>																	
	20 0000		<b>BASIC MECHANICAL CONDITIONS</b>														
	20 10 44		Seismic Restraint														
	20 10 80		Testing and Balancing (TAB)														
	20 10 90		Identification														
	21 0000		<b>FIRE PROTECTION SYSTEM</b>														
	21 00 06		Shop Drawings														
	21 00 21		Valves														
	21 00 22		Piping Materials and Fittings														
	21 00 23		Flexible Hoses														
	21 00 31		Sprinkler Heads														
	22 0000		<b>PLUMBING WORK</b>														
	22 20 00		Piping Materials and Fittings														
	22 30 01		Cleanouts														

SHOP DRAWING AND SUBMITTAL LOG

DATE REC'D	SUBMITTAL #	SPEC. SECTION #	 SPEC / SUBMITTAL DESCRIPTION	SUBCONTRACTOR	MUHC TO REVIEW	REFERRED				ACTION				COPIES TO						
						TO	SOA Transmittal No.	Date sent to Consultant	# COPIES	Date Rec'd from consultant	APPROVED	APPROVED AS CORRECTED	REVISE & RESUBMIT	REJECTED	SUBMIT SPECIFIC ITEM	Date Ret'd to General Contractor	SOA Transmittal No.	CONTRACTOR	OWNER - PROJ#4	CONSULTANT
		22 80 01	Backflow Preventer																	
		22 80 02	Hose Bibbs																	
		22 80 03	Roof Hydrants																	
		<b>23 0000</b>	<b>HVAC PIPING AND EQUIPMENT</b>																	
		23 10 01/02/0	Piping Materials and Fittings																	
		23 10 04	Hydronic Specialties																	
		23 10 05	Expansion Tanks																	
		23 21 41	In-line Pumps																	
		23 21 42	Base Mounted Pumps																	
		23 57 01	Heat Exchangers																	
		23 73 01	Custom Air Handling Units																	
		<b>23 0900</b>	<b>JCI Control Systems (MU)</b>																	
		23 09 00	Sequence of Operations																	
		23 09 00	Controls Wiring Diagrams																	
		23 09 00	Controls Parts & Pieces																	
		23 09 00	Control Dampers																	
		23 09 00	Control Valves																	
		<b>24 0000</b>	<b>AIR DISTRIBUTION</b>																	
		24 31 01 & 0	Sheetmetal Ductwork																	
		24 31 07	Pre-Fabricated Plenum Boxes																	
		24 31 08	Air Thermometers																	
		24 33 01	Balancing Damper																	
		24 33 03	Flexible Connectors																	
		24 33 04	Access Doors & Panels																	
		24 34 00	Fans																	
		24 41 01	Filter Housing																	
		24 41 02	Filters																	
		<b>26 05 73</b>	<b>ARC FLASH HAZARD ANALYSIS, SHORT CIRCUIT AND SELECTIVE DEVICE COORDINATION</b>																	
			Final Report																	
			Arc Flash Labels																	
		<b>26 24 00</b>	<b>SWITCHBOARDS AND PANELBOARDS</b>																	
			Product Data																	
			Shop Drawings																	
		<b>26 27 00</b>	<b>LOW VOLTAGE DISTRIBUTION EQUIPMENT</b>																	
			Product Data																	
		<b>26 28 00</b>	<b>LOW VOLTAGE CIRCUIT PROTECTIVE DEVICES</b>																	
			Product Data																	
		<b>26 29 00</b>	<b>LOW VOLTAGE CONTROLLERS</b>																	
			Product Data																	
			Shop Drawings																	

**CLOSEOUT LOG**

Project: **UMC Student Recreation Center – AHU 1-3 Replacement**

Project Number: **CP230262**

Contractor:

Section	Description	Contractor/Subcontractor	Date Rec'd	# of Copies	CPM Initials	Remarks
03 0000	CAST-IN-PLACE CONCRETE					
04 2200	CONCRETE UNIT MASONRY					
05 0000	STRUCTURAL STEEL					
05 4000	COLD-FORMED METAL FRAMING					
07 5216	STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING					
07 6200	SHEET METAL FLASHING AND TRIM					
07 7200	ROOF ACCESSORIES					
07 8413	PENETRATION FIRESTOPPING					
07 9200	JOINT SEALANTS					
09 2216	NON-STRUCTURAL METAL FRAMING					
09 9200	GYPSUM BOARD					
09 9123	INTERIOR PAINTING					
20 10 44	SEISMIC RESTRAINT					
20 10 80	TESTING AND BALANCING					
20 10 90	IDENTIFICATION					
21 00 06	SHOP DRAWINGS					

### CLOSEOUT LOG

Project: **UMC Student Recreation Center – AHU 1-3 Replacement**

Project Number: **CP230262**

Contractor:

Section	Description	Contractor/Subcontractor	Date Rec'd	# of Copies	CPM Initials	Remarks
21 00 21	VALVES					
21 00 22	PIPING MATERIALS AND FITTINGS					
21 00 23	FLEXIBLE HOSES					
21 00 31	SPRINKLER HEADS					
22 20 01	PIPING MATERIALS AND FITTINGS					
22 30 01	CLEANOUTS					
22 80 01	BACKFLOW PREVENTER					
22 80 02	HOSE BIBBS					
22 80 03	ROOF HYDRANTS					
23 00 06	MISC. CLOSEOUT DOCUMENTS					
23 10 00	PIPING MATERIALS AND FITTINGS					
23 10 04	HYDRONIC SPECIALTIES					
23 10 05	EXPANSION TANKS					
23 31 41	IN-LINE PUMPS					
23 31 42	BASE MOUNTED PUMPS					

**CLOSEOUT LOG**

Project: **UMC Student Recreation Center – AHU 1-3 Replacement**

Project Number: **CP230262**

Contractor:

Section	Description	Contractor/Subcontractor	Date Rec'd	# of Copies	CPM Initials	Remarks
23 57 01	HEAT EXCHANGERS					
23 73 01	CUSTOM AIR HANDLING UNITS					
23 09 00	SEQUENCE OF OPERATIONS					
23 09 00	TEMPERATURE CONTROLS PARTS & PIECES					
23 09 00	TEMPERATURE CONTROLS WIRING DIAGRAMS					
23 09 00	CONTROL DAMPERS					
23 09 00	CONTROL VALVES					
24 00 06	MISC. CLOSEOUT DOCUMENTS					
24 31 07	PRE-FABRICATED PLENUM BOXES					
24 31 08	AIR THERMOMETERS					
24 33 01	BALANCING DAMPERS					
24 34 00	FANS					
24 41 01	FILTER HOUSINGS					
24 41 02	FILTERS					

### CLOSEOUT LOG

Project: **UMC Student Recreation Center – AHU 1-3 Replacement**

Project Number: **CP230262**

Contractor:

Section	Description	Contractor/Subcontractor	Date Rec'd	# of Copies	CPM Initials	Remarks
26 27 26	WIRING DEVICES					
26 05 48	SEISMIC RESTRAINT					
26 24 13	SWITCHBOARD AND SWITCHES					
26 28 13	FUSES					
26 28 16	DISCONNECTS					
26 24 16	PANELBOARDS AND CIRCUIT BREAKERS					
26 29 23	VARIABLE FREQUENCY DRIVES					
26 29 13	MOTOR STARTERS/RIBs					

## OPERATING INSTRUCTIONS AND SERVICE MANUAL LOG

Project: **UMC Student Recreation Center – AHU 1-3 Replacement**

Project Number: **CP230262**

Construction Manager:

Section	Description	Catalog Data	Wiring Diagrams	Installation Instructions	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions
03 0000	CAST-IN-PLACE CONCRETE							
04 2200	CONCRETE UNIT MASONRY	X						
05 0000	STRUCTURAL STEEL							
05 4000	COLD-FORMED METAL FRAMING							
07 5216	STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING	X			X			
07 6200	SHEET METAL FLASHING AND TRIM	X			X			
07 7200	ROOF ACCESSORIES	X			X	X		
07 8413	PENETRATION FIRESTOPPING	X						
07 9200	JOINT SEALANTS	X						
09 2216	NON-STRUCTURAL METAL FRAMING							
09 9200	GYPSUM BOARD							
09 9123	INTERIOR PAINTING	X						
20 10 44	SEISMIC RESTRAINT	X		X				
20 10 80	TESTING AND BALANCING	X						
20 10 90	IDENTIFICATION	X						



## OPERATING INSTRUCTIONS AND SERVICE MANUAL LOG

Project: **UMC Student Recreation Center – AHU 1-3 Replacement**

Project Number: **CP230262**

Construction Manager:

Section	Description	Catalog Data	Wiring Diagrams	Installation Instructions	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions
21 00 06	SHOP DRAWINGS			X	X			
21 00 21	VALVES	X						
21 00 22	PIPING MATERIALS AND FITTINGS	X						
21 00 23	FLEXIBLE HOSES	X						
21 00 31	SPRINKLER HEADS	X				X		
22 20 01	PIPING MATERIALS AND FITTINGS	X						
22 30 01	CLEANOUTS	X						
22 80 01	BACKFLOW PREVENTER	X		X	X	X		
22 80 02	HOSE BIBBS	X						
22 80 03	ROOF HYDRANTS	X			X	X		
23 10 00	PIPING MATERIALS AND FITTINGS	X						
23 10 04	HYDRONIC SPECIALTIES	X						
23 10 05	EXPANSION TANKS	X			X	X		
23 31 41	IN-LINE PUMPS	X		X	X	X	X	X

## OPERATING INSTRUCTIONS AND SERVICE MANUAL LOG

Project: **UMC Student Recreation Center – AHU 1-3 Replacement**

Project Number: **CP230262**

Construction Manager:

Section	Description	Catalog Data	Wiring Diagrams	Installation Instructions	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions
23 31 42	BASE MOUNTED PUMPS	X		X	X	X	X	X
23 57 01	HEAT EXCHANGERS	X		X	X			
23 82 01	CUSTOM AIR HANDLING UNITS	X	X	X	X	X	X	X
23 09 00	TEMPERATURE CONTROLS PARTS & PIECES	X				X		
23 09 00	TEMPERATURE CONTROLS WIRING DIAGRAMS		X					
23 09 00	CONTROL DAMPERS	X		X	X			
23 09 00	CONTROL VALVES	X		X	X			
24 31 07	PRE-FABRICATED PLENUM BOXES	X						
24 31 08	AIR THERMOMETERS	X						
24 33 01	BALANCING DAMPERS	X			X			
24 34 00	FANS	X	X	X	X	X	X	X
24 41 01	FILTER HOUSINGS	X				X		
24 41 02	FILTERS	X				X		

## OPERATING INSTRUCTIONS AND SERVICE MANUAL LOG

Project: **UMC Student Recreation Center – AHU 1-3 Replacement**

Project Number: **CP230262**

Construction Manager:

Section	Description	Catalog Data	Wiring Diagrams	Installation Instructions	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions
26 05 73	LASH ANALYSIS, SHORT CIRCUIT AND SELECTIVE DEVICE COORDINATION				X		X	X
26 24 13	MAIN SWITCHBOARD	X	X		X			
26 24 16	PANELBOARDS	X	X		X			
26 27 26	WIRING DEVICES	X	X					
26 28 16	DISCONNECT SWITCHES	X			X			
26 29 13	MOTOR AND APPLIANCE CONTROL	X	X		X			X
26 29 23	VARIABLE FREQUENCY DRIVES	X	X		X			X

## SECTION 1.F INDEX OF DRAWINGS

UMC Student Recreation Center – AHU 4&5 Rebuilds, CP230261

Drawings referred to in and accompanying Project Manual consist of following sheets dated September 9, 2023.

### GENERAL

- CS.2 COVER SHEET
- G2.2 SITE / LOGISTICS PLAN
- G3.2 CODE SHEET / CONSTRUCTION ACCESS PLANS
- G4.2 CONSTRUCTION ACCESS PLAN

### ARCHITECTURAL

- A2.1E DEMO & NEW WORK MEZZANINE RCP EAST MECHANICAL
- A2.2E DEMO & NEW WORK SECOND FLOOR PLAN & RCP EAST MECHANICAL
- A2.3E NEW WORK SECOND FLOOR PLAN & SOUTHWEST OBSERVATION
- A2.4E DEMO & NEW WORK ROOF PLANS
- A3.1E BUILDING ELEVATIONS, PLAN & SECTION DETAILS

### STRUCTURAL

- S1.0 GENERAL STRUCTURAL DATA, PARTIAL FLOOR PLAN & DETAILS
- S2.0 PARTIAL ROOF FRAMING PLAN & DETAILS
- S2.1 ROOF FRAMING DETAILS
- S2.2 ROOF FRAMING DETAILS

### MECHANICAL

- DM2.0 MECHANICAL ROOM 301 DEMOLITION PLUMBING PLAN
- DM3.0 PARTIAL CHILLER ROOM M103 DEMOLITION FLOOR PLAN
- DM3.1 MECHANICAL ROOM 106B DEMOLITION
- DM3.2 MECHANICAL ROOM 118 DEMOLITION PLAN
- DM3.3 MEZZANINE FLOOR PLAN -EAST
- DM3.4 MECHANICAL ROOM 301 DEMOLITION PLAN
- DM3.5 MECHANICAL ROOM 301 ROOF DEMOLITION PLAN
- DM5.0 PAU -1/2/3 AIR FLOW DIAGRAM DEMOLITION
- DM5.1 CHILLED AND POOL WATER FLOW DIAGRAM DEMOLITION
- DM5.2 HEATING WATER FLOW DIAGRAM DEMOLITION
- DM5.3 HEATING WATER FLOW DIAGRAM DEMOLITION
- DM5.4 STEAM FLOW DIAGRAM DEMOLITION
- M1.0 MECHANICAL SYMBOLS AND ABBREVIATIONS
- M1.1 MECHANICAL DETAIL
- M1.2 MECHANICAL DETAIL
- M2.0 MECHANICAL ROOM 301 PLUMBING PLAN
- M3.0 PARTIAL CHILLER ROOM M103 NEW WORK PLAN
- M3.1 MECHANICAL ROOM 106B NEW WORK
- M3.2 MECHANICAL ROOM 118 NEW WORK PLAN
- M3.3 MEZZANINE FLOOR PLAN -EAST NEW WORK
- M3.4 MECHANICAL ROOM 301 NEW WORK PLAN
- M3.5 MECHANICAL ROOM 301 ROOF NEW WORK PLAN
- M3.6 SECOND FLOOR SOUTHWEST PLAN
- M4.0 MECHANICAL DUCTWORK SECTIONS
- M4.1 MECHANICAL 3D VIEWS
- M5.0 PAU -1/2/3 AIR FLOW DIAGRAM NEW WORK
- M5.1 CHILLED AND POOL WATER FLOW DIAGRAM NEW WORK
- M5.2 HEATING WATER FLOW DIAGRAM NEW WORK
- M5.3 HEATING WATER FLOW DIAGRAM NEW WORK

- M5.4 STEAM FLOW DIAGRAM NEW WORK
- M5.5 ENERGY RECOVERY SYSTEM FLOW DIAGRAM
- M5.6 PAU-1,2 CONTROLS DIAGRAM
- M6.0 MECHANICAL SCHEDULES
- M8.0 MISC. FIRE PROTECTION PLANS

ELECTRICAL

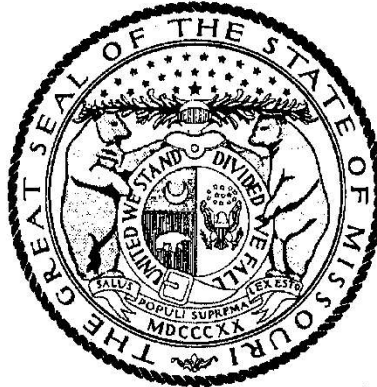
- E0.0 ELECTRICAL SCHEDULES AND DETAILS
- E0.1 ELECTRICAL ONE-LINE DIAGRAM -DEMOLITION
- E0.2 ELECTRICAL ONE-LINE DIAGRAM -NEW WORK
- E2.0 MECHANICAL ROOMS -ELECTRICALEMOLITION
- E2.1 MECHANICAL ROOM EAST -ELECTRICALEMOLITION
- E2.2 MECHANICAL ROOM EAST ROOF -ELECTRICALEMOLITION
- E3.0 MECHANICAL ROOMS -ELECTRICALNEW WORK
- E3.1 MECHANICAL ROOM EAST -ELECTRICALNEW WORK
- E3.2 MECHANICAL ROOM EAST ROOF -ELECTRICALNEW WORK

**END OF SECTION**

# Missouri

## Division of Labor Standards

### WAGE AND HOUR SECTION



MICHAEL L. PARSON, Governor

# Annual Wage Order No. 30

Section 010  
**BOONE COUNTY**

In accordance with Section 290.262 RSMo 2000, within thirty (30) days after a certified copy of this Annual Wage Order has been filed with the Secretary of State as indicated below, any person who may be affected by this Annual Wage Order may object by filing an objection in triplicate with the Labor and Industrial Relations Commission, P.O. Box 599, Jefferson City, MO 65102-0599. Such objections must set forth in writing the specific grounds of objection. Each objection shall certify that a copy has been furnished to the Division of Labor Standards, P.O. Box 449, Jefferson City, MO 65102-0449 pursuant to 8 CSR 20-5.010(1). A certified copy of the Annual Wage Order has been filed with the Secretary of State of Missouri.

Original Signed by

Todd Smith, Director  
Division of Labor Standards

Filed With Secretary of State: March 10, 2023

Last Date Objections May Be Filed: April 10, 2023

Prepared by Missouri Department of Labor and Industrial Relations

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	\$58.05
Boilermaker	\$73.87
Bricklayer	\$53.18
Carpenter	\$49.00
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	\$47.52
Plasterer	
Communications Technician	\$57.48
Electrician (Inside Wireman)	\$58.51
Electrician Outside Lineman	\$76.79
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	\$31.16*
Glazier	\$65.21
Ironworker	\$65.92
Laborer	\$42.86
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	\$31.16*
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	\$64.73
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	\$40.26
Plumber	\$69.73
Pipe Fitter	
Roofer	\$53.14
Sheet Metal Worker	\$56.02
Sprinkler Fitter	\$61.21
Truck Driver	\$31.16*
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

\*The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. The public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.

\*\*The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title as defined in RSMO Section 290.210.

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	\$53.37
Millwright	
Pile Driver	
Electrician (Outside Lineman)	\$76.79
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	\$46.32
General Laborer	
Skilled Laborer	
<b>Operating Engineer</b>	<b>\$65.15</b>
Group I	
Group II	
Group III	
Group IV	
Truck Driver	\$31.16*
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

Use Heavy Construction Rates on Highway and Heavy construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(3).

Use Building Construction Rates on Building construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(2).

If a worker is performing work on a heavy construction project within an occupational title that is not listed on the Heavy Construction Rate Sheet, use the rate for that occupational title as shown on the Building Construction Rate Sheet.

\*The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. Public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.

\*\*The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title.



# OVERTIME and HOLIDAYS

## OVERTIME

For all work performed on a Sunday or a holiday, not less than twice (2x) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work.

For all overtime work performed, not less than one and one-half (1½) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work or contractual obligation. For purposes of this subdivision, "**overtime work**" shall include work that exceeds ten hours in one day and work in excess of forty hours in one calendar week; and

A thirty-minute lunch period on each calendar day shall be allowed for each worker on a public works project, provided that such time shall not be considered as time worked.

## HOLIDAYS

January first;  
The last Monday in May;  
July fourth;  
The first Monday in September;  
November eleventh;  
The fourth Thursday in November; and  
December twenty-fifth;

If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

## SECTION 1.H ALTERNATES

Base Bid may be increased in accordance with following Additive Alternate proposal(s) as Owner may elect:

1. **Additive Alternate No. 1: Replace heating water piping at heat exchanger HX-3:**
  - a. **Base Bid:** No work to existing heat exchanger and adjacent piping.
  - b. **Alternate 1 Bid:** The scope of work includes all labor, materials, tools and equipment required to provide new piping to/from heat exchanger HX-3, located in the basement mechanical room, and as indicated on the following Drawings. The existing heat exchanger shall remain as-is.
    - i. Mechanical:
      - 1) Sheet DM3.1 – Demolition of existing piping at HX-3. Will require demolition of taps off HW mains in the same mechanical room.
      - 2) Sheet DM5.2 – Demolition of existing piping at HX-3.
      - 3) Sheet M3.1 – New piping and valving for HX-3. Will require new connection to HW mains in same mechanical room.
      - 4) Sheet M5.2 – New piping and valving for HX-3.

**END OF SECTION**

## SECTION 02 4119 - SELECTIVE DEMOLITION

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 1.E Special Conditions for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 1.E Special Conditions for temporary protection of existing trees and plants that are affected by selective demolition.
3. Section 017300 "Execution" 1.E Special Conditions for cutting and patching procedures.

#### 1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and store.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

#### 1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

#### 1.4 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site .

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

## **1.5 INFORMATIONAL SUBMITTALS**

- A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

## **1.6 FIELD CONDITIONS**

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
  1. Maintain fire-protection facilities in service during selective demolition operations.

## **1.7 COORDINATION**

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

### **3.2 PREPARATION**

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

### **3.3 PROTECTION**

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
  - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
  - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
  - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 5000 "Temporary Facilities and Controls."
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
  - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

### **3.4 SELECTIVE DEMOLITION, GENERAL**

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
  - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
  - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction.

- Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
  5. Maintain adequate ventilation when using cutting torches.
  6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
  7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
  8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  9. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
  2. Pack or crate items after cleaning and repairing. Identify contents of containers.
  3. Protect items from damage during transport and storage.
  4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

### 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least **3/4 inch** at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- D. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Section 075216 STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING for new roofing requirements.
1. Remove existing roof membrane, flashings, copings, and roof accessories.
  2. Remove existing roofing system down to substrate.

### **3.6 DISPOSAL OF DEMOLISHED MATERIALS**

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
  - 1. Do not allow demolished materials to accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
  - 4. Comply with requirements specified in Section 1.E Special Conditions
- B. Burning: Do not burn demolished materials.

### **3.7 CLEANING**

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

**END OF SECTION 02 4119**

## SECTION 05 4000 - COLD-FORMED METAL FRAMING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Exterior non-load-bearing wall framing.
- B. Related Requirements:
  - 1. Section 09 2216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Cold-formed steel framing materials.
  - 2. Exterior non-load-bearing wall framing.
  - 3. Vertical deflection clips.
  - 4. Drift clips.
  - 5. Power-actuated anchors.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. AllSteel & Gypsum Products, Inc.
  - 2. CEMCO; California Expanded Metal Products Co.
  - 3. ClarkDietrich.
  - 4. SCAFCO Steel Stud Company; Stone Group of Companies.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.



1. Design Loads: As indicated on Drawings .
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
  - a. Exterior Non-Load-Bearing Framing: Horizontal deflection of [1/240] [1/360] [1/600] [1/720] <Insert ratio> of the wall height.
3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
  - a. Upward and downward movement of [1/2 inch] [3/4 inch] [1 inch] [1-1/2 inches].
5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

### 2.3 COLD-FORMED STEEL FRAMING MATERIALS

- A. Framing Members, General: Comply with AISI S200 and ASTM C955, Section 8 AISI S240 for conditions indicated.
- B. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
  1. Grade: ST33H .
  2. Coating: G90 or equivalent .
- C. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:
  1. Grade: 33 .
  2. Coating: G90 .

### 2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
  1. Minimum Base-Metal Thickness: [0.0329 inch] [0.0428 inch] [0.0538 inch] [0.0677 inch] [0.0966 inch] <Insert dimension>.
  2. Flange Width: [1-3/8 inches] [1-5/8 inches] [2 inches] [2-1/2 inches] <Insert dimension>.
  3. Section Properties: <Insert minimum allowable calculated section modulus, moment of inertia, and allowable moment>.
- B. Vertical Deflection Clips, Exterior: Manufacturer's standard bypass head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
  1. [<Click here to find, evaluate, and insert list of manufacturers and products.>](#)

## **2.5 FRAMING ACCESSORIES**

- A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
  - 1. Stud kickers and knee braces.

## **2.6 ANCHORS, CLIPS, AND FASTENERS**

- A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.
- B. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
  - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- D. Welding Electrodes: Comply with AWS standards.

## **2.7 MISCELLANEOUS MATERIALS**

- A. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

## **2.8 FABRICATION**

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
  - 1. Fabricate framing assemblies using jigs or templates.
  - 2. Cut framing members by sawing or shearing; do not torch cut.
  - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
    - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
  - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of **1/8 inch in 10 feet** and as follows:
  - 1. Spacing: Space individual framing members no more than plus or minus **1/8 inch** from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.
  - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of **1/8 inch**.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than **1/4 inch** to ensure a uniform bearing surface on supporting concrete or masonry construction.

### **3.3 INSTALLATION, GENERAL**

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
  - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding **1/16 inch**.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
  - 1. Cut framing members by sawing or shearing; do not torch cut.
  - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
    - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

### 3.4 INSTALLATION OF EXTERIOR NONLOADBEARING WALL FRAMING

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
  - 1. Stud Spacing: **16 inches** .
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
  - 1. Install single deep-leg deflection tracks and anchor to building structure.
  - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
  - 3. Connect vertical deflection clips to **[bypassing] [infill]** studs and anchor to building structure.
  - 4. Connect drift clips to cold-formed steel framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated but not more than **48 inches** apart. Fasten at each stud intersection.
  - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
  - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
  - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within **[12 inches] [18 inches]** of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
  - 1. Install solid blocking at **[96-inch centers] [centers indicated] [centers indicated on Shop Drawings]**.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

### **3.5 INSTALLATION TOLERANCES**

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of **1/8 inch in 10 feet** and as follows:
  - 1. Space individual framing members no more than plus or minus **1/8 inch** from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

### **3.6 REPAIR**

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

### **3.7 PROTECTION**

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

**END OF SECTION 05 4000**

## SECTION 06 1000 - ROUGH CARPENTRY

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Wood blocking and nailers.
  2. Rooftop equipment bases and support curbs.

#### 1.2 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.
- C. Lumber grading agencies, and abbreviations used to reference them, include the following:
1. NeLMA: Northeastern Lumber Manufacturers' Association.
  2. NLGA: National Lumber Grades Authority.
  3. SPIB: The Southern Pine Inspection Bureau.
  4. WCLIB: West Coast Lumber Inspection Bureau.
  5. WWPA: Western Wood Products Association.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

### PART 2 - PRODUCTS

#### 2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
  2. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber:
1. Dimension Lumber: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

- C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
  - 1. Allowable design stresses, as published by manufacturer, are to meet or exceed those indicated. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

## **2.2 WOOD-PRESERVATIVE-TREATED MATERIALS**

- A. Preservative Treatment by Pressure Process: AWWA U1: Use Category UC3b for exterior construction not in contact with ground.
  - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

## **2.3 FIRE-RETARDANT TREATMENT**

- A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
  - 1. Treatment is not to promote corrosion of metal fasteners.
  - 2. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all rough carpentry unless otherwise indicated.

## 2.4 MISCELLANEOUS LUMBER

- A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
  - 1. Blocking.
- B. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber of any species.
- C. Concealed Boards: 15 percent maximum moisture content and any of the following species and grades:
  - 1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
  - 2. Hem-fir or hem-fir (north); Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
  - 3. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

## 2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

## 2.6 FASTENERS

- A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
  - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329 .
  - 2. For pressure-preservative-treated wood, use stainless steel fasteners.
- B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.



## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- C. Do not splice structural members between supports unless otherwise indicated.
- D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
  - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- E. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
  - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
  - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
  - 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
- F. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- G. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
  - 1. Use inorganic boron for items that are continuously protected from liquid water.
  - 2. Use copper naphthenate for items not continuously protected from liquid water.
- H. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- I. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

**END OF SECTION 06 1000**

## **SECTION 07 5216 - STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

A. Section Includes:

1. Cap sheet.
2. Substrate board.
3. Vapor retarder.
4. Roof insulation.
5. Cover board.
6. Walkways.
7. Accessory roofing system materials.
8. Insulation accessories.

B. Related Requirements:

1. Section 06 1053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
1. Section 07 6200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
2. Section 07 9200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

#### **1.2 DEFINITIONS**

- A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

#### **1.3 PREINSTALLATION MEETINGS**

A. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Construction Manager, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.
- B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
  - 1. Layout and thickness of insulation.
  - 2. Base flashings and membrane termination details.
  - 3. Flashing details at penetrations.
  - 4. Tapered insulation layout, thickness, and slopes.
  - 5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
  - 6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
  - 7. Tie-in with adjoining air barrier.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Sample Warranties: For manufacturer's special warranties.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Certified statement from existing roofing system manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

#### **1.7 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, certified, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

#### **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
  - 1. Protect stored liquid material from direct sunlight.
  - 2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.
  - 1. Store in a dry location.
  - 2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

## 1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

## 1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
  - 1. Special warranty to include all components of roofing system, such as vapor retarder, roof insulation, fasteners, adhesives, roofing membranes, base flashing sheet, and other components of roofing system.
  - 2. Warranty Period: continuation of existing 30 year warranty initiated years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SOURCE LIMITATIONS

- A. Obtain components for roofing system from manufacturer approved by roofing membrane manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.
- B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and installation required, as demonstrated by roofing membrane manufacturer based on testing and field experience.
- C. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
  - 1. Fire/Windstorm Classification: Class 1A-90 Class 1A-105 .

2. Hail-Resistance Rating: FM 1-34 MH SH VSH.
- D. Exterior Fire-Test Exposure: Class A ; for installation and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.
1. Identify products with appropriate markings of applicable testing agency.

### 2.3 CAP SHEET

- A. SBS-Modified Bitumen, Granule-Surfaced, Polyester and Glass-Fiber-Mat Cap Sheet: ASTM D6162/D6162M, Type I , Grade G, reinforced with a combination of polyester fabric and glass fibers, suitable for installation method specified.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed; SAINT-GOBAIN.
    - b. Garland Company, Inc. (The).
    - c. Johns Manville; a Berkshire Hathaway company.
    - d. Soprema, Inc.
    - e. Tremco Incorporated.
  2. Granule Color: White Gray to match existing .

### 2.4 ACCESSORY ROOFING SYSTEM MATERIALS

- A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use, compatible with other roofing components, and suitable for installation method specified.
- B. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- D. Cold-Applied Polymer-Modified Asphalt Adhesive: Roofing membrane manufacturer's standard solvent- and asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing membrane sheets base flashing sheets; designed for adhering roofing system components to substrate and each other, tested by roofing system manufacturer to meet performance requirements.
- E. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required by roofing membrane manufacturer.
- F. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.
- G. Self-Adhered Primer: Roofing membrane manufacturer's standard primer to enhance the adhesion of membrane to substrate.
- H. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

- I. Roofing Granules: Roofing membrane manufacturer's standard ceramic-coated mineral roofing granules, No. 11 screen size with 100 percent passing No. 8 sieve and 98 percent of mass retained on No. 40 sieve; color matching cap sheet.
- J. Safety Accessories: Roofing membrane manufacturer's standard yellow seaming tape for designating safety perimeters and rooftop hazards.
- K. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

## 2.5 SUBSTRATE BOARDS

- A. Substrate Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M, fiber-reinforced gypsum board.
  - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
    - a. [CertainTeed Corporation; Saint-Gobain North America.](#)
    - b. [Georgia-Pacific Gypsum LLC.](#)
    - c. [National Gypsum Company.](#)
    - d. [USG Corporation.](#)
  - 2. Thickness: **1/4 inch** thick.
  - 3. Surface Finish: Factory primed.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

## 2.6 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by SBS roof membrane manufacturer, approved for use in FM Approvals' RoofNav listed roof assemblies.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, **Grade 2**, felt or glass-fiber mat facer on both major surfaces.
  - 1. Minimum R-value – match existing,
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of **1/4 inch per 12 inches** unless otherwise indicated.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to match existing slopes.

## 2.7 INSULATION ACCESSORIES

- A. General: Roof insulation accessories as recommended in writing by roof membrane manufacturer for intended use, compatible with other roofing system components and suitable for installation method specified.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing membrane manufacturer.

- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate to another insulation layer as follows:
  - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
  - 2. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
- D. Insulation Cant Strips: ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board.
- E. Cover Board: ASTM C208, Type required to meet very severe hail by FM Global.

## 2.8 WALKWAYS

- A. Protective Walkways: SBS-Modified Bitumen, Granule-Surfaced, Polyester and Glass-Fiber-Mat Cap Sheet ASTM D6162/D6162M, Type I , Grade G, reinforced with a combination of polyester fabric and glass fibers, suitable for installation method specified and acceptable to roofing system manufacturer.
  - 1. Size: Approximately **36 inches in width**.
  - 2. Color: Contrasting with roof membrane.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Roofing System Installer present, for compliance with requirements and other conditions affecting performance of the Work.
  - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
  - 2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation in accordance with roofing system manufacturer's written instructions.
  - 1. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.
  - 1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

### 3.3 INSTALLATION OF ROOFING, GENERAL

- A. Complete terminations and base flashings. Provide temporary seals to prevent water from entering completed sections of roofing system at the end of workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.
- B. Install roofing membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing roofing system.
- C. Substrate-Joint Penetrations: Prevent hot-applied asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.
  1. ASTM D6162/D6162M, Type I , Grade G, reinforced with a combination of polyester fabric and glass fibers, suitable for installation method specified.

### 3.4 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
  1. Install base layer of insulation with joints staggered not less than **24 inches** in adjacent rows.
    - a. Locate end joints over crests of decking.
    - b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
    - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    - d. Make joints between adjacent insulation boards not more than **1/4 inch** in width.
    - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches**.
      - 1) Trim insulation so that water flow is unrestricted.
    - f. Fill gaps exceeding **1/4 inch** with insulation.
    - g. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
    - h. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
      - 1) Fasten insulation according to requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
      - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
  2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than **12 inches** from previous layer of insulation.
    - a. Staggered end joints within each layer not less than **24 inches** in adjacent rows.
    - b. Install with long joints continuous and with end joints staggered not less than **12 inches** in adjacent rows.
    - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    - d. Make joints between adjacent insulation boards not more than **1/4 inch** in width.
    - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches**.
      - 1) Trim insulation so that water flow is unrestricted.
    - f. Fill gaps exceeding **1/4 inch** with insulation.



- g. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
- h. Loosely lay each layer of insulation units over substrate.
- i. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
  - 1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

### **3.5 INSTALLATION OF COVER BOARDS**

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of **6 inches** in each direction.
  - 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - 2. At internal roof drains, conform to slope of drain sump.
    - a. Trim cover board so that water flow is unrestricted.
  - 3. Cut and fit cover board tight to nailers, projections, and penetrations.
  - 4. Loosely lay cover board over substrate.
  - 5. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
    - a. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing, and maintaining insulation in place.

### **3.6 INSTALLATION OF ROOFING MEMBRANE, GENERAL**

- A. Install roofing system in accordance with roofing system manufacturer's written installation instructions and applicable recommendations in NRCA's "Quality-Control Guidelines for the Application of Polymer-Modified Bitumen Roofing."
- B. Coordinate installation of roofing system so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at end of workday or when rain is forecast.
  - 1. Provide tie-offs at end of each day's work to cover exposed roofing sheets and insulation with a course of coated felt set in adhesive, with joints and edges sealed.
  - 2. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system.
  - 3. Remove and discard temporary seals before beginning work on adjoining roofing.

### **3.7 INSTALLATION OF CAP SHEET**

- A. Before installing, unroll cap sheet, cut into workable lengths, and allow to lie flat for a time period recommended by roofing membrane manufacturer for the ambient temperature at which cap sheet will be installed.
- B. Install cap sheet in accordance with roofing membrane manufacturer's written installation instructions, starting at low point of roof.
  - 1. Extend cap sheet over and terminate above cants.
  - 2. Install cap sheet in a shingle fashion.

3. Adhere cap sheet to bottom layer in a uniform coating of cold-applied adhesive.
  4. Self-adhere cap sheet to bottom layer.
  5. Heat-weld (torch-apply) cap sheet to bottom layer.
    - a. Perform heat-welded installation in accordance with NFPA 241, including two-hour fire watch after torches have been extinguished.
  6. Install cap sheet without wrinkles or tears, and free from air pockets.
  7. Install cap sheet so side and end laps shed water.
- C. Laps: Accurately align roof sheets, without stretching, and maintain uniform side and end laps.
1. Lap side laps as recommended by roofing membrane manufacturer but not less than 3 inches.
  2. Lap end laps as recommended by roofing membrane manufacturer but not less than 12 inches. Stagger end laps not less than 18 inches.
  3. Heat-weld laps, leaving no voids.
  4. Roll laps with a 20 lb roller.
  5. Repair tears and voids in laps and lapped seams not completely sealed.
- D. Apply pressure to body of cap sheet in accordance with roofing membrane manufacturer's written installation instructions, to remove air pockets and result in complete adhesion of cap sheet to substrate.

### **3.8 PROTECTING AND CLEANING**

- A. Protect roofing system from damage and wear during remainder of construction period.
1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

**END OF SECTION 07 5216**

## SECTION 07 6200 - SHEET METAL FLASHING AND TRIM

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Low-slope roof sheet metal fabrications.
  - 2. Miscellaneous sheet metal fabrications.

#### 1.2 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

#### 1.3 ACTION SUBMITTALS

- A. Product Data:
  - 1. Low-slope roof sheet metal fabrications.
  - 2. Miscellaneous sheet metal fabrications.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Special warranty.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
  - 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
  - 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

### 2.2 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, **G90** coating designation ; prepainted by coil-coating process to comply with ASTM A755/A755M.
  - 1. Surface: Smooth, flat and mill phosphatized for field painting .
  - 2. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (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.
  - 3. Color: As selected by Architect from manufacturer's full range .
  - 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of **0.5 mil**.

### 2.3 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.

- c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
- 2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch** wide and **1/8 inch** thick.
- D. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.
- F. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

## 2.4 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
  - 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
  - 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  - 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
  - 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
  - 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
  - 1. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
  - 1. Form expansion joints of intermeshing hooked flanges, not less than **1 inch** deep, filled with butyl sealant concealed within joints.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

H. Do not use graphite pencils to mark metal surfaces.

## 2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

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

### 3.2 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than **12 inches** o.c.
6. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
7. Do not field cut sheet metal flashing and trim by torch.

- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
  - 1. Coat concealed side of and sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
- C. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance .
- D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- E. Seal joints as required for watertight construction.
  - 1. Use sealant-filled joints unless otherwise indicated.
    - a. Embed hooked flanges of joint members not less than **1 inch** into sealant.
    - b. Form joints to completely conceal sealant.
    - c. When ambient temperature at time of installation is between **40 and 70 deg F**, set joint members for 50 percent movement each way.
    - d. Adjust setting proportionately for installation at higher ambient temperatures.
      - 1) Do not install sealant-type joints at temperatures below **40 deg F**.
  - 2. Prepare joints and apply sealants to comply with requirements in Section 07 9200 "Joint Sealants."
- F. Rivets: Rivet joints in zinc where necessary for strength.

### 3.3 INSTALLATION OF ROOF FLASHINGS

- A. Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard.
  - 1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
  - 2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of **4 inches** over base flashing. Install stainless steel draw band and tighten.
- C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
  - 1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
  - 2. Extend counterflashing **4 inches** over base flashing.
  - 3. Lap counterflashing joints minimum of **4 inches**.
  - 4. Secure in waterproof manner by means of anchor and washer spaced at **12 inches** o.c. along perimeter and **6 inches** o.c. at corners areas unless otherwise indicated.

### **3.4 INSTALLATION OF MISCELLANEOUS FLASHING**

- A. Equipment Support Flashing:
  - 1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
  - 2. Weld or seal flashing with elastomeric sealant to equipment support member.

### **3.5 INSTALLATION TOLERANCES**

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of **1/4 inch in 20 feet** on slope and location lines indicated on Drawings and within **1/8-inch** offset of adjoining faces and of alignment of matching profiles.

### **3.6 CLEANING**

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

### **3.7 PROTECTION**

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

**END OF SECTION 07 6200**



## SECTION 07 7200 - ROOF ACCESSORIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Pipe and duct support.
  - 2. Roof walkways and stairs.
- B. Related Requirements:
  - 1. Structural drawing sheets for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.

#### 1.3 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
  - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
  - 1. Size and location of roof accessories specified in this Section.

2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Steps:
  1. Step treads and stringers are designed to carry a uniform live load of 100 pounds per square foot and a concentrated vertical load of 300 pounds in an area of one square foot.
  2. Walking surfaces are designed to have a coefficient of friction no less than 0.50 in the normal direction of travel.
  3. Steps are designed to allow a minimum clearance of 48" between handrails.
  4. All step treads are designed to have a uniform depth of 12" with a 1" nosing for an effective run of 11" minimum per step, including the top step onto the platform / landing.
  5. All step nosings have a uniform radius of ¼" and an underside angle of 60 degrees from the horizontal.
  6. Step treads are designed to have a uniform height of either 6", 6-½", or 7" depending on the overall height of the step assembly. All step risers are closed between treads.
  7. Step tread widths are designed to allow a clearance of 48" between handrails.
- C. Step Rails
  1. All step rails are designed to withstand a concentrated load of 200 pounds applied in any direction on the top of the rail.
  2. Steps over 30": Step rails for steps with a vertical rise over 30" must have a 42" guardrail in addition to the 36" handrail.
  3. Steps 30" or under: Step rails for steps at 30" or under do not require a 42" guardrail.
  4. All baluster panels and other custom rail panels are designed to withstand a load of 50 pounds in the horizontal direction applied in an area of one square foot.
  5. All step rails will not allow a 4" diameter sphere to pass through in any area.
  6. Step rails are provided on both sides of the step treads.
  7. All step handrails are designed to be continuous along step runs and in between the inside corner of 90 degree and 180 degree turns in step direction. Handrails are not interrupted by posts or other obstructions.
  8. All handrails must have a clearance of 2-1/4" between the handrail and the guardrail.
  9. Step handrails are designed to be 36" high measured vertically from the top of the step nosing to the top of the rail.
  10. Step handrails extend 12" past the top step nosing parallel to the ground surface and return to the closest rail post or wall if needed due to door swing interference at the top of the

step. Step handrails also extend one tread width past the bottom step tread (11") and return to the closest rail post.

## 2.2 PIPE AND DUCT SUPPORTS

- A. Curb-Mounted Pipe Supports: Galvanized steel support with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom; with adjustable-height roller-bearing pipe support accommodating up to 20-inch- diameter pipe or conduit and with provision for pipe retainer; as required for quantity of pipe runs and sizes.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. MIRO Industries.
    - b. Pate Company (The).
    - c. PHP Systems/Design.
    - d. Thaler Metal Industries Ltd.

## 2.3 ROOF STAIRS

- A. Roof Walkway: Metal planking formed from multiple C-shaped channels with upper surface punched in serrated diamond or rectangular shapes to produce raised slip-resistant surface and drainage holes. Provide support framing, brackets, connectors, nosings, and other accessories and components needed for complete installation.
1. Include step units or stairs of similar construction for changes in elevation. Comply with ASCE-7, 29 CFR 1910.23, and requirements of authorities having jurisdiction.
  2. Equip stairs with safety railings.
  3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. MIRO Industries Inc.
    - b. PHP Systems/Design.
    - c. Upside Innovations, LLC.
  4. Support spacing: maximum of 5'-0"
  5. Grating: Bar grating type WB-4 or approved equal, carbon steel in accordance with ASTM A525.
    - a. Section width: 12"
    - b. Bar grating height: 1-inch minimum
    - c. Surface condition: Serrated.
  6. Handrail: 12 gauge, 1 5/8-inch strut G-5812, or approved equal.
  7. Bases: Manufacturer's standard High-Density Polypropylene plastic with additives for UV protection. Provide protective pads compatible with roofing material.
  8. Substructure: 12-gauge back to back strut G-1012A or approved equal supported directly from bases.
  9. All substructures and handrails shall be aluminum. Spring nuts and bolts for spring nuts will be electro-plated.

## 2.4 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation and mill phosphatized for field painting where indicated.
1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.

2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
  3. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
  4. Concealed Finish: Pretreat with 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.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, AZ50 coated.
1. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
  2. Concealed Finish: Pretreat with 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.
- C. Aluminum Sheet: ASTM B209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
1. Exposed Coil-Coated Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Two-Coat Fluoropolymer Finish: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
  2. Concealed Finish: Pretreat with 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.
- D. Aluminum Extrusions and Tubes: ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.
- E. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.
- F. Steel Shapes: ASTM A36/A36M, hot dip galvanized according to ASTM A123/A123M unless otherwise indicated.
- G. Steel Tube: ASTM A500/A500M, round tube.
- H. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.

- I. Steel Pipe: ASTM A53/A53M, galvanized.

## **2.5 MISCELLANEOUS MATERIALS**

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.
- C. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- D. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
  - 1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
  - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
  - 3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
- E. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- F. Elastomeric Sealant: ASTM C920, elastomeric polyurethane silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- G. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- H. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

## **2.6 GENERAL FINISH REQUIREMENTS**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install roof accessories according to manufacturer's written instructions.
  - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
  - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
  - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
  - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
  - 1. Coat concealed side of stainless-steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
  - 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
  - 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Pipe Support Installation: Comply with MSS SP-58 and MSS SP-89. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.
  - 1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
- D. Preformed Flashing-Sleeve Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.
- E. Roof Stair Installation:
  - 1. Verify that locations of access and servicing points for roof-mounted equipment are served by locations of roof walkways and stairs.
  - 2. Install substructures at spacing indicated on drawings, but not greater than 5'-0" on center.
  - 3. Locate bases and support framing as indicated on drawings and as specified here-n. Provide complete and adequate support of all structures.
  - 4. Accurately locate and align bases.
    - a. Consult Manufacturer of new roofing system to the type of isolation pads required between roof membrane and base.
    - b. Place bases on isolation pads.
  - 5. Set legs of substructures into bases as indicated.
  - 6. Use galvanized fasteners for framing.
  - 7. Layout and fasten planking to substructures.

8. Handrails: Install intermediate rails without tightening. Make minor adjustments as needed, such as spacing of substructures to accommodate intermediate handrails, and install hold downs. Secure intermediate handrails and install top handrails.

### **3.3 REPAIR AND CLEANING**

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 9113 "Exterior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

**END OF SECTION 07 7200**

## SECTION 07 8100 - APPLIED FIRE PROTECTION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Sprayed fire-resistive materials.

#### 1.2 DEFINITIONS

- A. SFRM: Sprayed fire-resistive materials.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site .
  - 1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

#### 1.4 ACTION SUBMITTALS

- A. Product Data:
  - 1. Sprayed fire-resistive materials.
  - 2. Substrate primers.
  - 3. Bonding agent.
  - 4. Metal lath.
  - 5. Reinforcing fabric.
  - 6. Reinforcing mesh.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer .

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by sprayed fire-resistive material manufacturer as experienced and with sufficient trained staff to install manufacturer's products in accordance with specified requirements.



## 1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is 44 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges in accordance with manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Assemblies: Provide fire protection, including auxiliary materials, in accordance with requirements of each fire-resistance design and manufacturer's written instructions.
- B. Fire-Resistance Design: Indicated on Drawings, tested in accordance with ASTM E119 or UL 263 ; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- C. Asbestos: Provide products containing no detectable asbestos.

### 2.2 SPRAYED FIRE-RESISTIVE MATERIALS

- A. Sprayed Fire-Resistive Material: UL G701, 2-Hour Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application or .
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carbolite Company; a subsidiary of RPM International.
    - b. GCP Applied Technologies Inc.
    - c. Isolatek International.
    - d. Southwest Fireproofing Products Co.
  - 2. Density: Not less than density specified in the approved fire-resistance design, in accordance with ASTM E605.
  - 3. Thickness: As required for fire-resistance design indicated, measured in accordance with requirements of fire-resistance design or ASTM E605, whichever is thicker, but not less than 0.5 inch.
  - 4. Combustion Characteristics: ASTM E136.
  - 5. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    - a. Flame-Spread Index: 10 or less.
    - b. Smoke-Developed Index: 10 or less.

## **2.3 AUXILIARY MATERIALS**

- A. Provide auxiliary materials that are compatible with sprayed fire-resistive material and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Substrate Primers: Primers approved by sprayed fire-resistive material manufacturer and complying with one or both of the following requirements:
  - 1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
  - 2. Primer's bond strength in required fire-resistance design complies with specified bond strength for sprayed fire-resistive material and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests in accordance with ASTM E736.
- C. Bonding Agent: Product approved by sprayed fire-resistive material manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.
- D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, in accordance with fire-resistance designs indicated and sprayed fire-resistive material manufacturer's written instructions. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive sprayed fire-resistive material.
- E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by sprayed fire-resistive material manufacturer.
- F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by sprayed fire-resistive material manufacturer. Include pins and attachment.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and in accordance with each fire-resistance design.
  - 1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.
  - 2. Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
  - 3. Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.
- B. Verify that concrete work on steel deck is complete before beginning Work.

- C. Conduct tests in accordance with sprayed fire-resistive material manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.
- B. Clean substrates of substances that could impair bond of fire protection.
- C. Prime substrates where included in fire-resistance design and where recommended in writing by sprayed fire-resistive material manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.
- D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

### **3.3 APPLICATION**

- A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fire protection Work.
- B. Comply with sprayed fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.
  - 1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
  - 2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.
- D. Metal Decks:
  - 1. Do not apply fire protection to underside of metal deck substrates until concrete topping, if any, is completed.
  - 2. Do not apply fire protection to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fire protection.
- E. Install auxiliary materials as required, as detailed, and in accordance with fire-resistance design and sprayed fire-resistive material manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer.

- F. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by sprayed fire-resistive material manufacturer.
- G. Extend fire protection in full thickness over entire area of each substrate to be protected.
- H. Install body of fire protection in a single course unless otherwise recommended in writing by sprayed fire-resistive material manufacturer.
- I. Where sealers are used, apply products that are tinted to differentiate them from fire protection over which they are applied.
- J. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.
- K. Cure fire protection in accordance with sprayed fire-resistive material manufacturer's written instructions.
- L. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.

### **3.4 FIELD QUALITY CONTROL**

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  - 1. Test and inspect as required by the IBC, Subsection 1705.13, "Sprayed Fire-Resistant Materials.
- B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.
- C. Fire protection will be considered defective if it does not pass tests and inspections.
  - 1. Remove and replace fire protection that does not pass tests and inspections, and retest.
  - 2. Apply additional fire protection, in accordance with manufacturer's written instructions, where test results indicate insufficient thickness, and retest.
- D. Prepare test and inspection reports.

### **3.5 CLEANING**

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

### **3.6 PROTECTION**

- A. Protect fire protection, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fire protection is without damage or deterioration at time of Substantial Completion.

### **3.7 REPAIRS**

- A. As installation of other construction proceeds, inspect fire protection and repair damaged areas and fire protection removed due to work of other trades.
- B. Repair fire protection damaged by other work before concealing it with other construction.
- C. Repair fire protection by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

**END OF SECTION 07 8100**

## SECTION 07 8413 - PENETRATION FIRESTOPPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Penetration firestopping systems for the following applications:
    - a. Penetrations in fire-resistance-rated walls.
    - b. Penetrations in horizontal assemblies.
- B. Related Requirements:
  - 1. Section 07 8443 "Joint Firestopping" for joints in or between fire-resistance-rated construction.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: Penetration firestopping systems.
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
  - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

## **1.6 CLOSEOUT SUBMITTALS**

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

## **1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

## **1.8 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

## **1.9 COORDINATION**

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Test-Response Characteristics:
  - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
  - 2. Test in accordance with testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
    - a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
      - 1) UL in its online directory "Product iQ."
      - 2) Intertek Group in its "Directory of Building Products."
      - 3) FM Approvals in its "Approval Guide."

## 2.2 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. 3M Building and Construction.
    - b. Hilti, Inc.
    - c. Specified Technologies, Inc.
    - d. Tremco Incorporated.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
  - 1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
  - 1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
- D. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
  - 1. Permanent forming/damming/backing materials.
  - 2. Substrate primers.
  - 3. Collars.
  - 4. Steel sleeves.

## 2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.



- F. Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.
- K. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.
- L. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use around rectangular steel HVAC ducts without fire dampers.
- M. Endothermic Wrap: Flexible, insulating, fire-resistant, endothermic wrap for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines.

## **2.4 MIXING**

- A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
  2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
  3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

### **3.3 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS**

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
  2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### **3.4 IDENTIFICATION**

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
  2. Contractor's name, address, and phone number.
  3. Designation of applicable testing and inspecting agency.

4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

### **3.5 FIELD QUALITY CONTROL**

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

### **3.6 CLEANING AND PROTECTION**

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

**END OF SECTION 07 8413**

## SECTION 07 9200 - JOINT SEALANTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Nonstaining silicone joint sealants.
  - 2. Urethane joint sealants.
  - 3. Mildew-resistant joint sealants.
  - 4. Butyl joint sealants.
  - 5. Latex joint sealants.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

#### 1.4 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
  - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F .
  - 2. When joint substrates are wet.
  - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## **1.5 WARRANTY**

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
  - 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
  - 2. Disintegration of joint substrates from causes exceeding design specifications.
  - 3. Mechanical damage caused by individuals, tools, or other outside agents.
  - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## **PART 2 - PRODUCTS**

### **2.1 JOINT SEALANTS, GENERAL**

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

### **2.2 NONSTAINING SILICONE JOINT SEALANTS**

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.
- B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Pecora Corporation.
    - b. Sika Corporation; Joint Sealants.
    - c. The Dow Chemical Company.
    - d. Tremco Incorporated.

### **2.3 URETHANE JOINT SEALANTS**

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. BASF Corporation.
  - b. Pecora Corporation.
  - c. Sika Corporation; Joint Sealants.
  - d. Tremco Incorporated.
  
- B. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 25, Uses T and NT.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. BASF Corporation.
    - b. Pecora Corporation.
    - c. Sika Corporation; Joint Sealants.

## **2.4 MILDEW-RESISTANT JOINT SEALANTS**

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
  
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
  
- C. STPE, Mildew Resistant, S, NS, 50, NT: Mildew-resistant, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

## **2.5 BUTYL JOINT SEALANTS**

- A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.

## **2.6 LATEX JOINT SEALANTS**

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

## **2.7 JOINT-SEALANT BACKING**

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
  
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) Type O (open-cell material) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application

indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

## **2.8 MISCELLANEOUS MATERIALS**

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    - a. Concrete.
    - b. Masonry.
  - 3. Remove laitance and form-release agents from concrete.
  - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
    - a. Metal.
    - b. Glass.

- c. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  - 1. Remove excess sealant from surfaces adjacent to joints.
  - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - 3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.



### **3.4 CLEANING**

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

### **3.5 PROTECTION**

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

### **3.6 JOINT-SEALANT SCHEDULE**

- A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces
  - 1. Joint Locations:
    - a. Construction joints in cast-in-place concrete.
    - b. Control and expansion joints in unit masonry.
    - c. Joints between metal panels.
    - d. Joints between different materials listed above.
    - e. Perimeter joints between materials listed above and frames of doors windows and louvers.
    - f. Control and expansion joints in ceilings and other overhead surfaces.
    - g. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT or Urethane, M, NS, 25, T, NT.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement
  - 1. Joint Locations:
    - a. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
    - b. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Acrylic.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces
  - 1. Joint Locations:
    - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
  - 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.\

4. Joint Sealant: Butyl-rubber based.
5. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

**END OF SECTION 07 9200**

## SECTION 08 9200 – LOUVERED EQUIPMENT ENCLOSURE

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Stationary blade equipment screen (horizontal).

#### 1.2 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing in accordance with AMCA 500-L.
- F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing in accordance with AMCA 540.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
  - 1. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For manufacturer's special warranties.

## 1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

## 1.6 WARRANTY

- A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.
  - 1. Wind Loads:
    - a. Determine loads based on pressures as indicated on Drawings.
- B. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

### 2.2 STATIONARY BLADE EQUIPMENT SCREEN (HORIZONTAL)

- A. Horizontal, Sightproof, Drainable-Blade Louver, Extruded Aluminum :
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.; EV811 or comparable product by one of the following:
    - a. Air Balance; MESTEK, Inc.
    - b. Airline Louvers; Mestek, Inc.
    - c. Airlite Company, LLC (The).
    - d. Arrow United Industries; Mestek, Inc.
    - e. Construction Specialties, Inc.
    - f. Greenheck Fan Corporation.
    - g. Industrial Louvers Inc.

- h. Pottorff.
  - 2. Louver Depth: 4 inches .
  - 3. Frame and Blade Nominal Thickness: Not less than 0.080 inch .
  - 4. Mullion Type: Exposed.
  - 5. Louver Performance Ratings:
    - a. Free Area: Not less than 7.1 sq. ft. for 48-inch- wide by 48-inch- high louver.

## 2.3 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
  - 1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
  - 2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
  - 3. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.4 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
  - 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern .
- C. Maintain equal louver blade spacing to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
  - 1. Frame Type: Channel unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches o.c., whichever is less.
  - 1. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.

- G. Join frame members to each other and to fixed louver blades with fillet welds , threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

## **2.5 ALUMINUM FINISHES**

- A. Finish louvers after assembly.
- B. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  - 1. Color and Gloss: As selected by Architect from manufacturer's full range .

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

### **3.3 INSTALLATION**

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

### **3.4 ADJUSTING AND CLEANING**

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
  - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

**END OF SECTION 08 9119**

## SECTION 09 2216 - NON-STRUCTURAL METAL FRAMING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Suspension systems for interior ceilings and soffits.
- B. Related Requirements:
  - 1. Section 09 2900 "Gypsum Board" for gypsum board sheathing at wall studs and ceilings.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

#### 2.2 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- B. Hanger Attachments to Concrete:
  - 1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 AC193 AC58 or AC308 as appropriate for the substrate.
    - a. Uses: Securing hangers to structure.
    - b. Type: Torque-controlled, expansion anchor torque-controlled, adhesive anchor or adhesive anchor.
    - c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.



- d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594 .
- 2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

## **2.3 AUXILIARY MATERIALS**

- A. General: Provide auxiliary materials that comply with referenced installation standards.
  - 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
  - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

### **3.3 INSTALLATION, GENERAL**

- A. Installation Standard: ASTM C 754.
  - 1. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
  - 2. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

**END OF SECTION 09 2216**

## SECTION 09 2900 - GYPSUM BOARD

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Interior gypsum board.
- B. Related Requirements:
  - 1. Section 09 2216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
  - 2. Section 09 9123 "Interior Painting" for primer and its application to gypsum board surfaces.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Mold-resistant gypsum board.
  - 2. Joint treatment materials.

#### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

#### 1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

### **2.2 GYPSUM BOARD, GENERAL**

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

### **2.3 INTERIOR GYPSUM BOARD**

- A. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Gypsum.
    - b. CertainTeed Corporation; Saint-Gobain North America.
    - c. Georgia-Pacific Gypsum LLC.
    - d. National Gypsum Company.
    - e. PABCO Gypsum.
    - f. USG Corporation.
  - 2. Core: 5/8 inch , Type X.
  - 3. Long Edges: Tapered.
  - 4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

### **2.4 JOINT TREATMENT MATERIALS**

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
  - 1. Interior Gypsum Board: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
  - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
  - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.

- a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.

## **2.5 AUXILIARY MATERIALS**

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
  1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
  2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Joint Sealant: As specified in Section 07 9200 "Joint Sealants."

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL**

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.

- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.
  - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

### **3.3 INSTALLATION OF INTERIOR GYPSUM BOARD**

- A. Install interior gypsum board in the following locations:
  - 1. Mold-Resistant Type: All surfaces.
- B. Single-Layer Application:
  - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
  - 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
    - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
  - 3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
  - 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

### **3.4 FINISHING GYPSUM BOARD**

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
  - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
  - 2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

- a. Primer and its application to surfaces are specified in Section 09 9123 "Interior Painting."

### **3.5 PROTECTION**

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
  1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**END OF SECTION 09 2900**

## SECTION 09 9123 - INTERIOR PAINTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
  - 1. Concrete masonry units (CMUs).
  - 2. Gypsum board.
- B. Related Requirements:
  - 1. Section 05 1200 "Structural Steel Framing" for shop priming structural steel.

#### 1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches' square.



2. Step coats on Samples to show each coat required for system.
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish quantity of one gallon for each type, and color of paint.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  1. Maintain containers in clean condition, free of foreign materials and residue.
  2. Remove rags and waste from storage areas daily.

### **1.7 FIELD CONDITIONS**

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated in Interior Painting Schedule or comparable product by one of the following:
  1. Benjamin Moore and Co.
  2. Sherwin-Williams Company
  3. PPG Architectural Finishes Inc.
- B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to products listed in the Interior Painting Schedule for the paint category indicated.

### **2.2 PAINT, GENERAL**

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: Contractor to review existing conditions, obtain paint samples and match existing paint product, color and finish sheen.

### **2.3 PRIMER/SEALER**

- A. Primer Sealer, Latex, Interior: MPI #50.

### **2.4 METAL PRIMERS**

- A. Primer, Alkyd, Anti-Corrosive, for Metal: MPI #79.
- B. Primer, Alkyd, Quick Dry, for Metal: MPI #76.

### **2.5 WATER-BASED PAINTS**

- A. Latex, Interior, High Performance Architectural, (Gloss Level 2): MPI #138.
- B. Latex, Interior, High Performance Architectural, Semi-Gloss (Gloss Level 5): MPI #141.

### **2.6 SOLVENT-BASED PAINTS**

- A. Alkyd, Interior, Semi-Gloss (Gloss Level 5): MPI #47.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Masonry (Clay and CMUs): 12 percent.
  2. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

### **3.2 PREPARATION**

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- E. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
- F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

### **3.3 APPLICATION**

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
  1. Use applicators and techniques suited for paint and substrate indicated.
  2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
  4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
  - 1. Paint the following work where exposed in equipment rooms:
    - a. Equipment, including panelboards.
  - 2. Paint the following work where exposed in occupied spaces:
    - a. Equipment, including panelboards.
    - b. Uninsulated metal piping.
    - c. Pipe hangers and supports.
    - d. Metal conduit.
    - e. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
    - f. Other items as directed by Architect.
  - 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

### **3.4 FIELD QUALITY CONTROL**

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
  - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
  - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

### **3.5 CLEANING AND PROTECTION**

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### **3.6 INTERIOR PAINTING SCHEDULE:**

- A. Gypsum Board Substrates:

1. Eggshell Latex (Walls):
    - a. Prime Coat: S-W ProMar 200 Zero VOC Latex Flat, B30-12600 Series
    - b. Intermediate and topcoats: S-W ProMar 200 HP Zero VOC Latex Eg-Shel, B20-1900 Series
  2. Flat Latex (Ceilings):
    - a. Prime Coat: S-W ProMar 200 Zero VOC Latex Flat, B30-12600 Series
    - b. Intermediate and topcoats: S-W ProMar 200 Zero VOC Latex Flat, B30-12600 Series
- B. Concrete Substrates: (IPS-3A)
1. Eggshell Latex (IPS-3A) – Finish Level to match existing (Eggshell or Semi-Gloss).
    - a. Prime Coat: S-W Pro Industrial Block Filler
    - b. Intermediate and topcoats: Intermediate and topcoats: S-W ProMar 200 HP Zero VOC Latex Eg-Shel

**END OF SECTION 09 9123**

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## **20 00 00 BASIC MECHANICAL CONDITIONS**

### **20 00 01 GENERAL**

- A. This Section includes general contractual, administrative and procedural requirements for the Work of Divisions 20 – 29 to supplement the requirements specified in Division 1.
- B. The organization of the Specifications into Divisions, Sections and Subsections, and the arrangement of the Plans shall not in and of itself divide the Work among the Contractors and Subcontractors nor establish the Work to be performed by any trade.
- C. The “Scope of Work” and “Work Included” under each respective sectional heading, nevertheless, attempts to segregate the Work by known contracting activities. In the final analysis, the General Contractor shall be responsible for scoping the work for each trade based on local practice to include all the Work of a given type in the related proposal, regardless of where and how identified in the Bid Documents.

### **20 00 02 SCOPE OF WORK**

- A. This project is for a renovated recreation center for the University of Missouri-Columbia located at 1000 Rollins St., Columbia, MO 65203. The design, defined by the Project Documents, provides for two renovated pool air handling units.
- B. The Mechanical Work for this project shall include all material, labor and services necessary for and incidental to providing the following systems (respective Sections of the Specifications are noted in the right hand column):
  - 1. Basic Mechanical Materials and Methods 20
  - 2. Insulation Work 20
  - 3. Fire protection system 21
  - 4. Plumbing Work 22
  - 5. HVAC Piping and Equipment 23
  - 6. Air Distribution 24

### **20 00 03 REFERENCES**

- A. The Plans, the general provisions of the Contract, including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Divisions 20 - 29 of the Specifications.
- B. All provisions and conditions cited in this Section shall apply to Work for all other sections of Divisions 20 – 29 of these Specifications.

### **20 00 04 REFERENCES, REGULATORY REQUIREMENTS**

- A. All material and equipment shall be listed, labeled or certified by Underwriters Laboratories, Inc., where relevant standards have been established (see also Paragraph 20 00 60). Material and equipment, which are not covered by UL Standards, will be acceptable provided they meet safety requirements of a nationally recognized testing laboratory. Products which no nationally recognized testing laboratory accepts, lists, labels, certifies or determines to be safe will be considered if inspected or tested in accordance with national industrial standards such as NEMA or ANSI. Evidence of compliance shall include test reports and definitive submittals.

- B. Pressure vessels and pressure retaining safety devices shall be certified in accordance with applicable requirements of the ASME Boiler Code.
- C. Definitions:
1. **“Listed”**: A product is “listed” if of a kind mentioned in a list which: Is published by a nationally recognized laboratory which makes periodic inspections of such production. States that such product meets nationally recognized standards or has been tested and found safe for use in a specified manner.
  2. **“Labeled”**: The product is “labeled” if: It embodies a valid label or other identifying mark of a nationally recognized testing laboratory such as UL, Inc. Production is inspected periodically by a nationally recognized testing laboratory. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
  3. **“Certified”**: The product is “certified” if: The product has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in specific manner. Production is inspected periodically by a nationally recognized testing laboratory. The product bears a label, tag or other record of certification.

20 00 05 DEFINITIONS

- A. The term **“Work”** used in this Division shall be the furnishing of material, labor and/or services necessary for and reasonably incidental to providing specific component(s), consideration(s) and/or system(s) of the design for the mechanical facilities for this Project as hereinafter defined by the Project Documents.
- B. The term **“Project Documents”** used in this Division shall be the compilation of the Specifications, the Plans and any Attachment and Addendum which collectively define the design and the intent of the Work to construct the Project.
- C. The terms **“Architect”** and **“Engineer”** as used in this Division of the Specifications shall be the professional individual and/or company developing the respective portion(s) of the Project Documents and administering the responsibility for the adherence to the intent of these documents. The “Architect/Engineer” is the agent of the “Owner”, and shall represent and discharge authority on all matters unless the matter is referred to the Owner or the Owner elects to perform in their own behalf.
- D. The term **“General Contractor, Construction Manager, or Prime Contractor”** as used in Division 20 shall mean the Contractor who has the prime contract with the Owner and who is responsible for general conditions of the project and is responsible for seeking experienced and qualified Trade Subcontractors to perform the Work.
- E. The terms **“Contractor”** and **“Subcontractor”** where used in this Division shall mean any Company, regularly in business, to perform the type of work for which the Contract was sought, who has contracted with the Owner or General Contractor to perform the work included in and defined by this section and any other section or sections of this Division.
- F. The term **“submittal”** as used in this Section of the Specifications shall be construed to be information in various forms compiled by the Contractor to transmit to the Architect/Engineer for review, comment and/or approval and return same to the Contractor with notice to react. The information shall support and/or substantiate that the given product complies with the intent of the Project Documents, should be incorporated in the Work and therefore, warrants approval to permit proceeding with that Work. The information may be any form or accepted practice of shop drawings, data, published catalogs, etc. that sufficiently provide the Architect/Engineer with basis of making a determination.

- G. The term “**unfinished space**” as used in Division 20 - 25 of the Specifications shall be a mechanical or electrical equipment room. These are rooms that are generally unpainted and accessible only to building maintenance personnel.
- H. The term “**finished space**” as used in Division 20 - 25 of the Specifications shall mean any space not defined as “unfinished space” (i.e. occupied rooms, corridors, stairways, closets, etc.).
- I. The term “**exterior**” or “**outdoors**” as used in Division 20 - 25 of the Specifications shall mean exposed to atmospheric weather conditions.
- J. The term “**interior**” or “**indoors**” as used in Division 20 - 25 of the Specifications shall mean not exposed to atmospheric weather conditions.
- K. The term “**concealed**” as used in Division 20 - 25 of the Specifications shall mean anything that is not visible in a “finished space”.
- L. The term “**inaccessible**” as used in Division 20 - 25 of the Specifications shall mean located within walls or above non-lay-in ceiling (i.e., drywall, plaster).
- M. The term “**packaged**” as used in Division 20 - 25 of the Specifications shall be construed to be a factory manufactured piece of equipment for which all components are totally assembled, prepiped and prewired within its own structure and ready to operate when connected to proper external mechanical and electrical services.
- N. The term “**cold piping system**” as used in Division 20 - 25 of the Specifications shall be a piping system containing media at or below 79 degrees F temperature.
- O. The term “**ambient piping system**” as used in Division 20 - 25 of the Specifications shall be a piping system containing media which is neither heated nor chilled and remains at a temperature range between 80 and 109 degrees F temperature.
- P. The term “**hot piping system**” as used in Division 20 - 25 of the Specifications shall be a piping system containing media at or above 110 degrees temperature.

20 00 06 CODES, STANDARDS, ETC.

- A. The material, workmanship and systems for Work of this Division shall comply with all applicable codes, standards, regulations and laws of the legal governmental jurisdiction at the project site.
- B. Should the Contractor perform any work that does not comply with the requirements of the applicable codes, standards, regulations, statutes, laws, acts, or which does not receive the approval of the responsible inspection authority, Contractor shall bear all costs arising in correcting the deficiencies.
- C. Applicable requirements of the current and accepted edition of the following codes shall apply to the Work for Divisions 20 – 29:
  - International Building Code 2021
  - International Existing Building Code 2021
  - International Mechanical Code 2021
  - International Plumbing Code 2021
  - International Fire Code 2021
  - International Fuel Gas Code 2021
  - International Swimming Pool and Spa Code 2021
  - International Energy Conservation Code 2021

- National Electrical Code, 2020
- Code of Federal Regulations (CFR)
- Code of State of Missouri Regulation
- University of Missouri adopting Ordinances, Laws and Statutes
- ICC A117.1 Accessable and Usable Buildings and Facilities 2017
- NFPA 110 Standard for Emergency and Standby Power Systems
- NFPA 90A Installation of Air Conditioning and Ventilating Systems 2018
- NFPA 72 Fire Alarm Code 2019
- NFPA 51B Standard for Fire Prevention During Welding, Cutting, and Other Hot Work 2019
- NFPA 13 Installation of Fire Sprinkler Systems 2019

D. Applicable requirements of the current and accepted edition of the following industry standards, codes and specifications shall apply to the Work for Divisions 20 - 29:

AMCA	Air Moving and Conditioning Association	24 00 00
ANSI	American National Standards Institute	20 10 00
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers	
ASME	American Society of Mechanical Engineers	20 10 00
ASSE	American Society of Sanitary Engineers	22 00 00
ASTM	American Society of Testing and Materials	20 10 00
AWS	American Welding Society	23 00 00
AWWA	American Water Works Association	22 00 00
IEEE	Institute of Electrical & Electronic Engineers	
IPCEA	Insulated Power Cable Engineers Association	
MSS	Manufacturers Standardization Society of Valve and Fitting Industry	20 10 00
NIST	Institute of Science and Technology	20 10 00
NEC	National Electric Code, including amendments by local authority having jurisdiction	
NEMA	National Electrical Manufacturers Association	
NFPA	National Fire Protection Association	21 00 00
NSF	National Sanitation Foundation	22 00 00
NIOSH	National Institute of Occupational Safety and Health	
OSHA	Occupational Safety and Health Act	
SMACNA	Sheet Metal and Air Conditioning Contractors National Association	24 00 00
UL	Underwriters Laboratory, Inc.	

E. Applicable requirements of all the relevant Federal laws including current and accepted edition of the Americans with Disabilities Act (ADA).

**20 00 20 CONDITIONS, JOBSITE**

20 00 21 REQUIREMENTS TO PURSUE THE WORK

A. Work space: The respective Contractors and Subcontractors shall be assigned areas at the job site for construction trailers, lay-down, storage and work spaces as arranged with the General Contractor/Owner. All spaces shall be accessible to the Architect/Engineer. All material and equipment shall be protected during the course of construction against weather, dirt, comprehensive damage and theft. All items subject to water damage shall be adequately protected. Damage occurring or defects detected before acceptance shall be repaired or replaced at no additional compensation.

- B. Tools: The Contractors and Subcontractors shall provide their own tools and services to perform their respective Work. Rented or leased services shall have proper and adequate insurance in accordance with requirements of Division 1.
- C. Temporary storage: The Contractors and Subcontractors shall be responsible for any requirements to temporarily store material and equipment until it is incorporated into the Project.

#### 20 00 23 ADDITIONAL REQUIREMENTS AND SPECIAL CONDITIONS

- A. Replacement of the air handling units shall be phased. At no time shall PAU-2 & 3 both be out of operation. Moreover, downtime of the PAUs shall follow the construction schedule designated by the owner to avoid capacity short-falls during events in the natatoriums.

#### **20 00 30 PROJECT DOCUMENTS**

##### 20 00 31 GENERAL

- B. The Plans and the Specifications are intended to define complete and satisfactorily functioning systems. The Contractor shall be responsible for providing all necessary material, labor and services to provide the completed, operating systems at no additional compensation even though each and every element thereof is not specifically identified.
- C. The Plans are diagrammatic and indicate general arrangements, approximate sizes and relative locations of principal equipment and materials to provide for the design and intent of the Mechanical Work, and shall be followed as closely as actual building and site conditions and other work permit. Because of the scale of the drawings, the Plans do not represent every offset, fitting, accessory, etc. that may be required for the piping, ductwork or other appurtenances, nor is it implied that all conflicts between elements of the Work or building components have been resolved. The Contractor shall prepare details and/or coordination drawings where it may be required and submit to the Architect/Engineer for approval before proceeding with the Work (see Subsection 20 10 53, Coordination).
- D. To the extent contained in the Project Documents, elevations, sections, isometrics, typical details, and schematic diagrams are included for instructions to the craftsperson. If any additional isometrics or diagrams are desired and/or required for further instruction to the craftsperson, for permit applications, or for any other reason, the Contractor shall develop the drawings.
- E. Significant discrepancies and/or changes required to accomplish the intent of the Project Documents, in the opinion of the Contractor, shall be identified and submitted to the Architect/Engineer for approval before proceeding with the Work in question. Changes originated by the Architect/Engineer shall be processed under the subsection heading "Changes in the Work".
- E. The Plans and the Specifications are mutually complementary. Work required by one, but not the other, shall be performed as if required by both.
- G. In the event of conflict between the Plans and the Specifications, the Contractor shall notify the Engineer for clarification. The Contractor shall assume that the stricter requirements apply when there is not sufficient time for the clarification request, or when there is not sufficient time for it to be answered.

20 00 32 SPECIFICATIONS

A. The specification for Divisions 20 – 29 includes the following sections:

20	Basic Mechanical Conditions
20	Basic Mechanical Materials and Methods
20	Insulation Work
21	Fire Protection System
22	Plumbing Systems
23	HVAC Piping and Equipment
24	Air Distribution System
25	Temperature Control System

H. Referenced sections of other Divisions whether attached or in separate volumes or binders shall be a part of the Contract Documents.

20 00 33 ADDENDUM

- A. The Architect/Engineer may issue revisions, modifications, attachments or other documentation in the form of an “addendum” to the Project (Bid) Documents during the bidding phase only to change, detail or clarify the scope of the Work.
- B. The “addendum” shall become a part of the Contract Documents. Contractor shall indicate on his Bid the addenda received and therefore included in the Bid.

20 00 34 INTERPRETATIONS

A. The Architect/Engineer shall be the sole source of interpretation of the design and intent of the Project Documents.

20 00 35 CONSTRUCTION SCHEDULE

- A. The Contractor shall furnish sufficient manpower as the schedule dictates and is required to maintain the overall project schedule. Manpower or overtime to meet the project schedule including, but not limited to, premium time, inefficiencies associated with longer days/hours, inefficiencies associated with additional manpower, or other labor burdens shall be included in the Contract Sum.
- B. The Work shall be scheduled in accordance with the General, Supplementary and/or Special Conditions and specification sections of Division 1. The respective contractor shall coordinate with this schedule in preparation of his schedule for his portion of the Work.
- I. The respective Contractor shall cooperate with the General Contractor and other trades to develop an overall project schedule.

20 00 36 RECORD DRAWINGS

A. The respective Contractor shall maintain a separate set of plans at the jobsite, and mark thereon as a “record” any changes in the Work as the construction proceeds. These record drawings shall include exact locations and relevant details (i.e. inverts, elevations, sizes, dimensions related to building lines, etc.) of all underground work, all concealed work, all considerations requiring periodic attention and access thereto (i.e. valves, air vents, dampers, drives, control devices, terminal units, filters, steam traps, strainers, etc.).

## 20 00 37 AS-BUILT DRAWINGS

- A. At the completion of the project, the Architect/Engineer will provide Contractor CADD files in AutoCAD Release 2000 format, or lower, for the Contractors use to transfer all of the information on the "record" drawings to CADD. The layering system on the drawings provided shall be strictly adhered to. The Contractor for their representation and accuracy of the final installation conditions shall certify these "as-built" drawings. The "as-built" diskette and blue line prints shall be submitted to the Architect/Engineer for approval. Upon approval contractor shall provide a mylar plot in addition to the diskette/CD-ROM and blue line prints. The Contractor shall be responsible for all costs associated with the preparation and printing of the "as-built" drawings.
- B. In addition to the information on the "record" drawings the "as-built" drawings will contain the following information: Updated Equipment Schedules with shop drawing data and valve tag numbers placed on the flow diagrams.
- C. Contractor shall maintain one copy of the specification, including addenda as Record Specifications. Mark to show variations in Work performed in comparison with the text of the specifications. Such variations shall only be permitted where agreed to by the Architect/Engineer in writing.

## **20 00 40 DUTIES OF CONTRACTOR**

### 20 00 41 GENERAL (PURSUIT OF WORK)

- A. The Contractor shall thoroughly examine all Bid Documents before submitting a bid/proposal for the Work. If in the opinion of the Contractor there are any deficiencies in the Documents that might impact on the intent or the scope of the work, the Contractor shall bring the matter to the attention of the Architect/ Engineer for clarification. If in the judgment of the Architect/Engineer such clarification is warranted, an addendum to the Documents will be issued. If the Contractor fails to request clarification or otherwise submits a bid without qualifications; the Contractor thereby agrees to install a complete and functional system with no change in the contract price.
- B. The Contractor shall be responsible for changes required for compliance with codes, standards, regulations, ordinances, etc. and implementing any such change at no change in contract price. In the event of conflict with the Project Documents or other requirements, the more stringent shall apply. The Contractor shall promptly notify the Architect/Engineer of any discrepancy.
- C. The Contractor shall perform the Work to comply with all terms, conditions and intentions, whether explicit or implicit, of this Section and applicable requirements of other Sections of Divisions 20 - 29, the Plans and any other documentation so identified. Should the Contractor perform any Work, which does not comply with the Project Documents or is not in accordance with common trade practices, the Contractor shall bear all costs, at no change in contract price, arising in correcting the Work.
- D. The Contractor shall be responsible for all aspects of the Work for their respective contractual agreement. The Work of the respective suppliers and subcontractors shall be administered properly to assure that all elements thereof have been provided for complete and functioning system(s).

### 20 00 42 COMMENCEMENT OF CONTRACT

- A. The commencement of the Contract work shall be the receipt by the Contractor of a written "Notice to Proceed" via certified United States Postal Service (USPS) mail.

- B. Any further notices to stop and/or restart the Work shall also be transmitted via certified USPS mail. All other correspondence shall be at the discretion of the sender.

20 00 43 SEISMIC ANCHORAGE, BRACING AND SWAY BRACING

- A. The Contractor shall be responsible for preparing drawings, calculations and details for any anchorage, bracing and/or sway bracing as required by the Authority Having Jurisdiction. Submitted drawings, calculations and details shall be signed and sealed by a Professional Engineer licensed in the State of Missouri.

20 00 44 SUBMITTALS FOR APPROVAL

- A. The Contractor shall submit a list of proposed subcontractors and equipment suppliers within two (2) weeks of a Notice to Proceed. The list shall identify the Work to be subcontracted and the name of the proposed subcontractor; the equipment to be provided including the make, model number and vendor's name and reference to the specific subsection(s) of the Specifications. Approval of this list does not obligate the Architect/Engineer to approve the subsequent detailed submittal if it is not acceptable.
- B. All shop drawings (except sprinkler drawings) must be submitted prior to the receipt of second partial payment request. After the first payment has been made, no further payment will be made until the shop drawings have been submitted and approved. Sprinkler shop drawings must be submitted prior to the receipt of the fourth partial payment request. After the third payment has been made, no further payment will be made until these shop drawings have been submitted and approved.
- C. The Contractor shall forward the quantity required for distribution within a reasonable time following the award of the contract. In addition to the quantity the Contractor requires the Engineer will retain one (1) copy and four (4) sets should be reserved for closeout documentation (see Section 20 00 47 Catalog Data). Prior to submitting shop drawings, Contractor shall verify equipment delivery for compliance with the overall project schedule. Any delays due to delivery or due to submittals being late, inadequate, or incorrect and therefore rejected by the Architect/Engineer shall be the responsibility of the Contractor making said submittal. The Contractor shall bear all cost for expediting charges or obtaining materials from another vendor to meet the overall project schedule.
- D. The Engineer may take up to three (3) weeks to review a submittal from the time it arrives at the Engineer's office until the time it is returned to the Architect. Resubmittals will be reviewed within two (2) weeks from the time they arrive at the Engineer's office until the time they are returned to the Architect.
- E. The submittals shall include shop drawings, engineering data and support information to sufficiently substantiate compliance with the Project Documents, and shall have been processed in accordance with Subsection 20 00 43. All submittals must include the following information in order to be considered for review. Submittals found to be lacking will be processed without review.
  1. Shop drawing shall be manufacturer's original documents; no reproductions or telefaxes will be accepted.
  2. Stamped date of receipt by the Contractor.
  3. Identification of the project name.
  4. Indication that the Contractor has reviewed the submittal.
  5. Identification of the Specification section or subsection that specifies the submitted item.



6. Identification of the submitted item by the same description that is used in the Project Documents.
7. Quantity to be provided. The Contractor shall make an independent count and not rely on the Project Documents.
- E. The approval of the submittal shall not relieve the Contractor from complying with all of the terms and conditions of the Project Documents. The Contractor shall be responsible for all physical and performance requirements of equipment provided, including any differences in the cost of installation for variations from these requirements.
- G. Include one (1) copy of the manufacturer's installation instructions and maintenance manual with the equipment submittal for approval for inclusion in the Operations and Maintenance Manuals as specified in Subsection 20 00 46.
- H. Items requiring submittals are listed in each section where the equipment or materials are specified. In general, all items purchased by Contractor for installation where a make and model is specified shall require submittals. Items required for the Work such as sand paper, bolts, gaskets, welding rods, etc. which are not specified are not required to be submitted unless specifically requested.
- I. The following shall be submitted under this section of the specifications:
  1. List of subcontractors and equipment supplier.
  2. Payment breakdown.
  3. Construction Schedule.
  4. Detailed submittals.
  5. Catalog Data
  6. Operating and maintenance manuals.
  7. As-built drawings.
  8. Contractor developed details and coordination drawings (when applicable).
  9. Proposed substitution (when applicable).

20 00 45 CHANGES IN WORK

- A. The only condition under which a change in the contract price will be considered is if there is to be a change in the scope of intent of the project requirements. Such changes would be limited to revisions in the project initiated by the Owner. The Architect/Engineer will issue a proposal for the new scope of work for the Contractor to prepare a price. When the price and time are agreed upon, the Architect/Engineer will prepare change order or change orders to adjust the contract sum and/or the contract time as necessary to carry out the changes.
- B. No claim for an addition to the Contract Sum will be valid unless authorized as aforesaid in writing by the Owner. Any work completed by the Contractor outside the original project scope without written approval from the Owner will be deemed as a waiver by the Contractor for additional compensation for said work.
- C. No requests for change orders will be reviewed or considered for approval that are not submitted with all of the following information. No cost associated with labor burden or manpower inefficiencies will be approved for a change order without documentation of the present labor burden, manpower requirements, and the critical path nature of the scope change.
  1. A complete and detailed line item takeoff of materials and equipment.

2. A unit cost identified for each line item with material cost, labor hours, and labor rate identified separately for each line item.
  3. All fringes and mark-ups identified separately.
- D. Where major subcontracts are involved, the respective subcontractor's calculation, including all of the above data, shall be included with the Contractor's request.
- E. Where there are net differences, the above data shall be included for all items added and for all items deducted with the net calculation clearly identified. Mark-ups shall be applied only after net differences are calculated.
- E. The overhead charged by the Contractor shall be considered to include, but not limited to, performance bond, insurance, job site office expense, normal hand tools, man-lifts, incidental job supervision, field supervision, safety training, general office overhead, and cost associated with the preparation of design documents, layout drawings, shop drawings, or as-built drawings.
- G. In evaluating the value of the contractor's request, for comparison purposes, the Architect/Engineer may use cost and unit data from the current edition of the R. S. Means Company's Cost Data, or information from appropriate suppliers or vendors of the respective materials or equipment.
- H. Any requests submitted without the above details will be returned without review for resubmittal in the proper form.

#### 20 00 46 COMPLETION AND ACCEPTANCE

- A. If, at the Owner's option, a portion of the building is to be occupied or a portion of the mechanical work is utilized for beneficial use by the Owner prior to completion and acceptance of the Project, the start of the guarantee shall begin with the "beneficial use" of the related Work.
- B. The Engineer shall inspect the portion of the system for approval prior to acceptance of the system or subsystem.
- C. The Contractor shall prepare a certificate of acceptance for approval by the Owner for that portion of the Work and submit a copy to the Architect/Engineer for record purposes.

#### 20 00 47 OPERATIONS AND MAINTENANCE MANUALS

- A. As a part of the contractual agreement, the Contractor shall submit and receive approval for the following to receive payment beyond 75% of the contract amount. This information shall be submitted as soon as practical and while the Contractor is on site.
1. Provide four (4) sets of manufacturers printed information in three (3) ring binders containing information on installation operation and maintenance for each piece of equipment supplied. Manufacturer's information shall be original copies, no reproduction or telefaxes will be accepted.
  2. The information shall list any maintenance requirements and schedule for required maintenance.
  3. The information shall show all parts and part numbers of available replacement parts available for each piece of equipment.
  4. A cross-index of material and equipment furnished containing:
  5. An alphabetical listing of material and equipment.
  6. An alphabetical listing by manufacturer's name, address and contact person of the local sales representative.

7. An alphabetical listing of all subcontractors including name, address, contact person, and specific work performed.

20 00 48 CATALOG DATA

- A. As a part of the contractual agreement, the Contractor shall submit and receive approval for the following to receive payment beyond 75% of the contract amount. This information shall be submitted as soon as all shop drawings have been approved and while the Contractor is on site.
  1. Provide four (4) sets of only those shop drawings that were approved and incorporated into the project.
  2. A cross-index of material and equipment furnished containing:
  3. An alphabetical listing of material and equipment.
  4. An alphabetical listing by manufacturer's name, address and contact person of the local sales representative.
  5. An alphabetical listing of all subcontractors including name, address, contact person, and specific work performed.

20 00 49 CLOSE-OUT REQUIREMENTS

- A. As a part of the contractual agreement, the Contractor shall submit and receive approval for the following before final payment will be released. This information shall be submitted as soon as practical after project completion:
  1. Testing and Balancing Reports.
  2. Temperature controls as-built wiring diagrams, sequences of operation with daily, holiday and special operating schedules, and final calibrations of all instruments.
  3. Valve tag list.
  4. As-built drawings.
  5. At the completion of the project, all contractors/subcontractors shall submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.

20 00 50 GUARANTEE

- A. The Contractor shall guarantee all material, equipment and workmanship provided for this project to be free from defects for a period of one (1) year after final acceptance. The guarantee shall include replacement of the defective part(s) and related labor. Manufacturer's written guarantees shall be provided where it is published.
- B. Any obvious defects shall be corrected before final acceptance. For additional defects after final acceptance, the Owner shall advise the Contractor in writing, unless the situation is urgent, to address the deficiency or malfunction. The Contractor shall respond promptly and with no additional compensation for a valid guarantee claim.
- C. Longer guarantee periods of time or special conditions may be specified. See particular specifications for these requirements.
- D. If a written guarantee is offered for conditions or period exceeding specified requirements; this guarantee shall be included in the "Close-out" specifications of Subsection 20 00 48.

- E. The Contractor shall not qualify the guarantee with requirements placed upon the Owner. If the Contractor has concerns with maintenance of a piece of equipment then Contractor shall allow for making periodic inspections, adjustments, etc. during the warranty period.

#### 20 00 51 PAYMENTS

- A. The Contractor shall submit for approval by the Architect/Engineer, at least four (4) weeks prior to the first request for payment, a format utilizing AIA form G702 of an itemized cost breakdown of all systems (material and labor), subsystems (material and labor), and major equipment groups to be invoiced for progress payments.
- B. The Contractors of Divisions 20 - 29 will also be subjected to the following requirements for payments in addition to the requirements specified in the General Conditions or Division 1:
  - 1. The Contractor shall submit all shop drawings [except temperature control and sprinkler drawings] prior to receiving the second partial payment, see Section 20 00 43.
  - 2. Payments will be for the total of the approved payment request, less a retainage of 10%.
  - 3. The Contractor shall submit Operations and Maintenance Manuals and Catalog Data prior to receiving payment beyond 75% of the contract amount, see sections 20 00 46 and 20 00 47, respectively.
  - 4. The Contractor shall submit Closeout Documents prior to receiving final payment, see section 20 00 48.

#### **20 00 50 MATERIAL AND EQUIPMENT**

- A. General
- B. All equipment and materials furnished and installed by Contractor shall be new. The equipment to be furnished and installed shall be standard cataloged products of manufacturers regularly engaged in the production of this type of equipment and shall be of the latest design. Equipment of the same general type shall be of the same make throughout the Project.
- C. Manufacturers shall have been in business for two (2) consecutive years operating under the same name
- D. Products shall be in production at time of the bid date. A scheduled release of a new product during construction is not acceptable. Prototype, alpha or beta products shall not be used.
- E. Products for which fewer than 100 units have been produced and which have been in service for less than one year shall be submitted for approval, in writing, to the Engineer in writing prior to bid date.
- F. The Contractor shall be responsible for the physical fit and configuration of the equipment to suit the space available and the intent of the Work. Due consideration shall be included for external connections and service maintenance access to the equipment.
- G. The Contractor shall verify in the course of preparing the submittal that the respective material and equipment comply with the following criteria of the Project Documents:
- H. The performance ratings meet the specified requirements.
- I. The mechanical and electrical physical characteristics meet the specified requirements.
- J. The identification of the material or equipment to catalog data is correct and proper.

- K. Confirm (or establish) the quantity required.
- L. The application of the material or equipment is acceptable to the manufacturer and to the intent of the scope of Work.
- M. Any inability of material and/or equipment to comply with the aforementioned criteria shall be promptly brought to the attention of Architect/Engineer.

#### 20 00 51 EQUIPMENT MANUFACTURERS

- A. The equipment manufacturer may be specified in any one of the following manners. "Equivalent" shall mean, equivalent in the opinion of the Engineer. Where equipment is scheduled on the drawings, the scheduled manufacturer is what the design is based upon:
  - 1. Single manufacturer named, "No substitution allowed":  
The intent is to use the particular make and model only, no other shall be considered.
  - 2. Single manufacturer named:  
Single manufacturer named followed by "or approved equivalent":  
The design has been based on this particular make and model for acceptable physical characteristics, performance and quality. Any other comparable and equivalent product may be substituted in accordance with procedures for submittals and approvals (Subsection 20 00 43) and conditions of Subsection 20 00 52, Equipment substitution.
  - 3. Limited multiple manufacturers named:  
The design has been based on the first named manufacturer for acceptable physical characteristics, performance and quality. Any one of the other limited named manufacturers is equally acceptable in quality and may be substituted in accordance with procedures for submittals and approvals (Subsection 20 00 43) and conditions of Subsection 20 00 52, Equipment substitution.
  - 4. Limited multiple manufacturers named followed by "or approved equivalent": The design is based on the first named manufacturer for acceptable physical characteristics, performance and quality. Any one of the other limited named manufacturers is equally acceptable in quality and along with other comparable and equivalent product may be substituted in accordance with procedures for submittals and approvals (Subsection 20 00 43) and conditions of Subsection 20 00 52, Equipment substitution.
  - 5. List of "Acceptable Manufacturers":  
Where a specific product from a manufacturer is listed along with the words "Acceptable Manufacturers" and a list of manufacturers this equal product(s) of any of the limited list may be submitted without concern from Subsection 20 00 52.
- B. The Contractor shall follow the option specified from above as applied to each respective material and equipment specification subsection. The Contractor shall indicate within the options allowed the respective supply source(s) for the listing requested in Subsection 20 00 43. The Contractor shall assume all responsibilities and liabilities of "or equivalent" substitutions (see Subsection 20 00 52).
- C. The Contractor shall prepare and transmit submittals for approval, even for the option of Subsection 20 00 51.

#### 20 00 52 EQUIPMENT SUBSTITUTION

- A. General: As previously stated, the design has been based on a single manufacturer and model. Substitution, where permitted (as described above), may cause consequential effects that may impact on the Project. These effects may take various forms and may require changes in the

design. These changes and any additional costs associated therewith are the responsibility of the Contractor proposing the substitution; no additional compensation shall be provided to the Contractor.

- B. A possible change in design may result from the proposed substitution from one or more of, but not limited to, the following conditions:
1. Architectural: different physical configuration, size or fit, aesthetics effected.
  2. Structural: different bearing or heavier loading.
  3. Capacity: different performance, lesser output is unacceptable.
  4. Mechanical: change in flow rates (air, water, etc.), different configuration and size of external piping or ductwork connections.
  5. Electrical: different horsepower requirements, effect on distribution.
  6. Controls: interconnections with control devices and equipment, additional requirements.
  7. Impact on environmental or energy efficiency issues.
  8. Departure from intent of original design or Project Documents.
- C. Changes in loading, sizing and/or performance of the proposed substitution shall consider the total requirements served or needed by the particular equipment. A revised design to accommodate the substitution shall be extended to the point where the change has no effect on the parameters used in the original design.
- D. An equipment substitution requiring a change in the design shall be processed as follows:
1. The Contractor shall prepare and submit to the Architect/Engineer for review, a proposal to provide a substitution that shall require a change in the design. Substantiate that the substitution complies with the intent of the Project Documents and include sufficient information of the changes required so that a judgment may be rendered.
  2. Proposal shall include an original drawing originated by the Contractor, and shall not be a catalog cut, assembly manual, or other generic documented printed by the manufacturer or their representative. The design shall show the intended installation to the same level of detail as that of the original design.
  3. Prior to submitting the proposal, the Contractor shall notify all other contractors whose work may be affected and request details and pricing for their respective changes. This information along with the Contractor's details shall be transmitted to the Architect/Engineer for approval.
  4. The Contractor in preparing the proposal recognizes that they shall compensate other trades that are affected by said proposal.
  5. If the proposal and the substitution are acceptable, the Architect/Engineer will approve the submittal and initiate a change order, at no additional compensation, and a notice to proceed.
- E. Equipment that was listed as a multiple manufacturer with a model number shall be submitted as a shop drawing. Contractor shall be responsible for all other provisions of Section 20 00 52. If, and only if, the material or equipment substitution requires no design change, the Work shall proceed in accordance with the Product Documents.
- E. Equipment that is being proposed as 'or equivalent' or was listed as a multiple manufacturer without a model number shall be in the form of a written proposal before the shop drawing phase. 'Or equivalent' shall mean or equivalent in the opinion of the Architect/Engineer and they shall have sole discretion to determine whether or not a proposed substitute manufacturer and/or

model is to be considered as acceptably equivalent and may be submitted in the form of shop drawings. If, and only if, the material or equipment substitution requires no design change, the Work shall proceed in accordance with the Project Documents.

- G. If changes are in fact required or a delay in work occurs because of the material or equipment substitution which were not properly processed, the Contractor initiating the substitution shall be liable for all consequential effects and expenses to accommodate the change or delay.

END OF SECTION

## **20 10 00 BASIC MECHANICAL MATERIALS and METHODS**

### 20 10 01 GENERAL

- A. This Section describes and specifies basic mechanical materials and methods to be utilized in the Work included in other sections of Divisions 20 - 25.
- B. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Divisions 20 - 25 of the Specifications.
- C. Provisions and conditions cited in this Section shall apply, where and when relevant, to Work of other sections of Divisions 20 - 25 of these Specifications.

### 20 10 02 REGULATORY REQUIREMENTS

- A. Work for this section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20.

### 20 10 03 RELATED SECTIONS of the SPECIFICATIONS

- A. Requirements of the following Section(s) of the Specifications apply to Work of this Section:
- B. Division 20 - Basic Mechanical Conditions
- C. Requirements of this Section of the Specifications shall apply to Work of the following sections of Divisions 20 - 29:
  - 1. Division 20 - Insulation Work
  - 2. Division 21 - Fire Protection System
  - 3. Division 22 - Plumbing Work
  - 4. Division 23 - HVAC Piping and Equipment
  - 5. Division 24 - Air Distribution System

### 20 10 04 WORK INCLUDED

- A. Furnish material, labor and services necessary for and incidental to the installation of the following work where shown on the Plans and as hereinafter specified. Include all necessary work in related sections of the Specifications (sub-section 20 10 03) to perform the Work completely.
- B. Identification of piping and equipment for the work of Divisions 20 - 25.
- C. Testing, adjusting and balancing of systems for the work of Divisions 20 - 25.
- D. Cleaning of piping and equipment for the work of Divisions 20 - 25.
- E. Painting of piping and equipment for the work of Divisions 20 - 25.
- F. Demolition for the work of Divisions 20 - 25.
- G. Concrete for the work of Divisions 20 - 25.

### 20 10 05 WORK NOT INCLUDED

- A. Materials and methods are specified in this section for the work of Divisions 20 - 25. The Work, itself, is specified in the respective sections of Divisions 20 - 25 of the Specifications.



#### 20 10 06 SUBMITTALS

- A. The Contractor shall submit materials for the Work of Divisions 20 - 25 for approval in accordance with Section 20 00 43. The requirements are enumerated in the respective sections of Divisions 20 - 25 of the Specifications.
- B. Single and multiple manufacturers are cited in this Sub-section as acceptable sources of piping material. While "or equivalent" is not included, the intent of this Section is to permit substitution as defined in Sub-section 20 00 51, EQUIPMENT MANUFACTURERS, unless "no substitution allowed " is noted.
- C. The following shall be submitted under this section of the specification:
  - 1. Firestop schedule and product data, see Section 20 10 20 for specific requirements.
  - 2. Testing and Balancing, see Section 20 10 80 for specific requirements.
  - 3. Identification, see Section 20 10 90 for specific requirements.

#### 20 10 07 SPECIAL REQUIREMENTS

- A. Special requirements for work shall be specified in the respective sections of Divisions 20 - 25 of the Specifications.

#### 20 10 08 ABOVE CEILING IDENTIFICATION

- A. All equipment items (i.e., pumps, fire dampers, duct access panels, VAV boxes, etc.) concealed above a ceiling shall be identified with ceiling marker tacks similar to Markserv Ceiling Markers, Equipment Locator Tacks. Provide serrated makers with retention disk. Color code equipment markers for each equipment item above ceiling. Coordinate color strategy with owner.

#### **20 10 10 BASIC PIPING MATERIALS**

- A. General:
  - 1. The intent of sub-sections 20 10 11, 20 10 12, and 20 10 13 is to identify materials that may be utilized for Divisions 20 - 25 Work as specified for each specific piping system. Piping, hangers, valves, fittings and joining materials for Division 21 Fire Protection shall be FM Global and U.L. listed as specified in Division 21 and may not necessarily be as specified in this section; however all methods and procedures which are not in conflict with those permitted by NFPA shall govern.
  - 2. Respective piping materials shall be manufactured, fabricated and/or provided in accordance with the ANSI, ASTM, ASME or other accepted industry standard as specified herein.

#### 20 10 11 PIPE AND TUBE

- A. General:
  - 1. All pipe and tube material shall be uncoated, unless specified otherwise.
  - 2. Manufacturer's mill reports and applicable documents to certify the validity of procured piping materials shall be on file at the Contractor's office.
- B. Steel pipe:

- Steel pipe shall be specified by finish, size by nominal diameter, ASTM specification number, manufacturing process, wall thickness (by schedule number or decimal dimension) and end preparation as follows:

2.

ASTM finish	mfr. spec#	wall method	size thickness	end range	prep
black	A-53	CW/ERW	Sch 40, 80	2" and smaller	T&C
black	A-53	SMLS PE/T&C	Std, Sch 40,80	all	
black	A-106	SMLS Grade A PE/T&C	Std, Sch 40,80	all	
galv	A-53	SMLS Grade A PE/T&C	Std, Sch 40,80	all	

- Per ANSI B36.10, schedule 40 is standard weight pipe for 10" pipe size and smaller.
- Schedule 80 in this pipe size range is extra strong pipe.
- Standard weight pipe for all sizes 12" and larger is 0.375" wall thickness and are generally not referred to by schedule number.
- Outside diameters of pipe sizes 14" and larger are even whole numbers (e.g. - 18" O.D., 20" O.D., etc.)

CW = continuous weld  
 ERW = electric resistance weld  
 SMLS = seamless  
 PE = plain end  
 T&C = threaded and coupled

- All steel pipe shall be mill coated and rust free.

C. Copper tube:

- Type K, L, and M copper tube shall be in accordance with ASTM B88. Tubing is available in various finished products and wall thickness, which must be called out as well as sizes being either "nominal" or "outside diameter" (O.D.) since there are overlaps in smaller sizes.

2.

type	size range	annealed		application
		hard	soft	
K	1/4"-2"		x	heaviest wall, underground water (ASTM B-88)
L	1/4"-8"	x		general use, HVAC, refriger., plumbing (ASTM B-88)
M	1/4"-8"	x		lightest, gravity drains and vents (ASTM B-88)
DWV	1-1/4"-6"	x		plumbing drains and vents (ASTM B-306)

D. Plastic pipe:

- PVC pressure rated schedule 40 (white) and schedule 80 (gray) pipe shall be in conformance with ASTM D-1785.
- CPVC pressure rated Schedule 40 and Schedule 80 pipe shall be in conformance with ASTM F-441.
- PVC DWV pipe for non-pressure applications shall be schedule 40 pipe in conformance with ASTM D-1785.

## 20 10 12 FITTINGS

### A. Cast iron:

1. Screwed fittings and flange unions: 125# standard and 250# extra heavy threaded in accordance with ANSI B16.4 (except plugs and bushings which are ANSI B16.14). Available in black or galvanized, range 1/4" - 8".
2. Flanged fittings and flanges: 125# standard, flat faced in accordance with ANSI B16.1. 250# extra heavy, raised face in accordance with ANSI B16.2. Flange facing and drilling shall be in accordance with ANSI B16.5. Available black and limited galvanized, range 1-1/2" - 12".
3. Flanged elbows shall be long radius (1.5 x diameter), short radius elbow are not permitted, unless specifically noted.

### B. Butt weld:

1. Butt welding fittings shall be in accordance with ASTM A-234 and ANSI B16.9. End preparation of butt welding fittings shall be in accordance with ANSI B16.25.
2. Elbows shall be long radius (1.5 x diameter), short radius elbows, and 180-degree returns are not permitted, unless specifically noted.

### C. Forged steel flanges:

1. 150# and 300# forged steel flanges shall be manufactured to the requirements of ASTM A-181 with dimension in accordance to ANSI B16.5. Flange faces shall be flat or raised face as required.
2. Forged steel flanges shall be furnished as weld neck pattern. Slip-on, lightweight slip-on (drilled to 125# ANSI standards) and orifice flanges shall be provided only where specified and/or noted.

### D. Copper (alloy and bronze) shall be in conformance with the following ANSI specifications:

1. Cast bronze threaded fittings: ANSI B16.15
2. Cast copper alloy solder fittings: ANSI B16.18
3. Wrought copper pressure solder fittings: ANSI B16.22
4. Cast copper DWV solder fittings: ANSI B16.23
5. Cast bronze flanged fittings: ANSI B16.24
6. Cast copper alloy for flared tubing: ANSI B16.26
7. Wrought copper DWV solder fittings: ANSI B16.29
8. Short radius 90 degrees elbows and 180 degree returns are not permitted, unless specified and/or specifically noted.

### E. Grooved:

1. All grooved components shall be of one manufacturer made in accordance with ANSI B-31.1, B-31.9. Fittings shall be ANSI 150#, 300# cast of ductile iron in accordance with ASTM A-536, Grade 65-45-12. Fittings shall have an enamel finish. Segmentally welded fittings are not acceptable.
2. Only the following fittings will be accepted: Long radius (1.5 x diameter) 90° and 45° elbows, tee, reducing tee, concentric/eccentric reducers, and flange adapter nipples. Flange rings, reducing couplings, saddle/mechanical/clamp branch tee, and others not listed above are not acceptable.

### E. Plastic:

1. PVC DWV fittings for non-pressure applications shall be in accordance with ASTM D-2665 and NSF Standard 14.

G. Miscellaneous

1. Dielectric flanges and unions:
2. Dielectric unions and flange unions shall be required in piping systems where an electrically insulated connection is needed to separate dissimilar metals from producing galvanic or electrolytic action. Unions shall be rated for 250#; flange unions for 175#. Range: unions ½" - 2"; flange unions 1-1/2" - 12".
3. Steel threaded nipples:
4. General use: Made from ASTM A-120 pipe in standard (schedule 40) and extra strong (schedule 80). Available black and galvanized, range 1/8" - 6" pipe diameters.
5. High-pressure application: Made from ASTM A-53 seamless pipe and ASTM A106 seamless pressure tube in standard (schedule 40) and extra strong (schedule 80). Available black only, range 2" - 6" pipe diameters.
6. Close nipples are not permitted.

20 10 13 VALVES

A. General:

1. It is indented that valves specifications are for high quality HVAC / Plumbing applications, not lesser quality "Contractor / Value / Economy" series. Valves produced internationally shall be from the Manufacturer's owned facilities. Valves shall not be manufactured by third party OEM suppliers. Valve submittal shall indicate where the valve is assembled and tested.
2. When two or more valves of the same type are to be used in the same service, all valves of this type shall be of the same manufacturer.
3. Only general valve series are specified. Valves shall have all options, trim, seat material, and accessories as specified whether or not listed as a prefix, suffix or valve number.
4. All valve manufacturers and models listed shall be considered as "acceptable manufacturers" and may be submitted without concern from subsection 20 00 62
5. All valves for use in "cold" piping shall have stem or neck extensions allowing proper insulation and a continuous vapor barrier.
6. No asbestos packing allowed.

B. Ball Valve:

1. 2" and smaller: Bronze ASTM B584 (or low lead bronze for lead-free), 2-piece body, 600 psi WOG, quarter turn lever handle, blow-out proof stem, stem extension (for "cold" applications), full port, virgin TFE seats, all stainless steel trim, threaded or soldered ends. Nibco S-585-70-66, Apollo 77-240, Watts Series B-6081, Hammond 8311 or approved equivalent. Full port valves 2 ½" and 3" the same model numbers as the 2" and smaller valves are also acceptable.
2. 2-1/2" - 3": Bronze ASTM B584 (or low lead bronze for lead-free), 2-piece body, 600 psi WOG, quarter turn lever handle, blow-out proof stem, stem extension (for "cold" applications), standard port, virgin TFE seats, all stainless steel trim, threaded or soldered ends. Nibco S-585-66, Apollo 70-240, Watts Series B-6001, Hammond 8511 or approved equivalent. Full port valves 2 ½" and 3" the same model numbers as the 2" and smaller valves are also acceptable.

3. Ball valves used for chilled water shall have insulated T-handle Nibco Nib-Seal, Apollo ThermaSeal, Hammond Valve Insulator/MS.
4. Gauge cocks where not specified or specifically identified shall be ¼" bronze 2 piece body ball valves with lever handle and threaded ends per the above specification.
5. Drain valves and air vents shall be ¾" bronze 2 piece body ball valves per the above specification, with ¾" hose end adapter cap and chain. In ½" through 2" pipe, contractor may use Webstone model T-drain.

C. Butterfly:

1. 2" - 24": Class 200 ASTM A395 ductile iron body, threaded lug type, 1/4 turn, extended neck, peroxide cured EPDM molded-in seat liner, aluminum bronze disc, 416 SS stem, lubersized bronze or Teflon bushings, and stem seals material matching the seat material. Conforms to MSS SP-67 & API 609. Bi-directional bubble tight dead end service with no downstream flange required rated at 200 psi for 2-12", or 150psi 14" and larger. Valve body shall an integrally cast top plate for direct flush mounting of manual or power actuators without the use of brackets or adapters.
  - a. Refer to subsequent paragraphs for operator type based on size and service.
  - b. Valves shall be chemically compatible with: up to 4ppm of Chloramines (NH<sub>2</sub>Cl, NHCl<sub>2</sub>, NCl<sub>3</sub>) 40°F-200°F, propylene glycol 0°F-200°F; and NSF-61 rated 40°F-180°F.
  - c. Where used in potable water valve shall be "lead free" per 2011 Reduction of Lead in Drinking Water Act.
  - d. Valve submittal shall indicate where the valve is assembled and tested.
  - e. Valves shall be NIBCO figure LD 2000, Milwaukee ML-133E, Hammond 6411, Bray 31H, Apollo LD-145, Watts DBF-03, or approved equivalent. The following valves are **NOT** equivalent NIBCO N200, Milwaukee CL series, Hammond 5000 series, Apollo LC series, Watts BF series, or Crane 200 series.
2. Service valves 6" and less shall have a 10-position lever handle; balance valves shall have infinitely adjustable lever handle with memory stop locking option. Service valves and balance valves 8" and larger shall have position indicating worm gear operators with handwheel operator. Control valves shall have actuators as specified in Division 25.
3. Where valves are located above 10'-0" AFF provide gear operator with chain wheel and guide. Provide chain hoods where required, to prevent fouling of chains on equipment and to clear walkways. Terminate chains approximately 6'-3" above the floor.

D. Balancing Valves:

1. General: Balance valves shall provide positive shut-off for service and shall have adjustable memory stops to allow returning to original balanced position after servicing.
2. 3" and smaller: Body shall be bronze or Dezincification Resistant Brass rated to 300 psig. Valves shall be multi-turn, provide positive shut off; include: position indication, memory stops, integral pressure tap ports provided with "drip caps". Quarter turn valves are not acceptable. Balance valves shall be Nibco 1810, Tour and Anderson 786/787, Apollo 59A, Armstrong CBV, Macon Balancing STV/L Series or approved equivalent.
3. 4" – 12": Body shall be iron body rated to 300psig with 150# flanges. Valves shall be multi-turn, provide positive shut off; include: position indication, memory stops, integral pressure tap ports provided with "drip caps". Quarter turn valves are not acceptable. Balance valves shall be Nibco F739, Tour & Anderson 788, Apollo 58A, Armstrong CBV, Macon Balancing STV, Watts CSM-91, or approved equivalent.

E. Check:

1. Check valves installed at pump discharge size 2 ½ and larger shall be Silent type, size 2" and smaller may be swing type.
2. 2" and smaller: Class 125 (125 psi at 400°F, 200 psi at 150°F), bronze, horizontal swing, vertical up-flow, Y pattern, teflon renewable seat and disc in conformance with MSS SP80. Nibco 413, Grinnell 3300, Watts 5000, Crane 1707, Hammond IB904, Stockham B320, or approved equivalent.
3. 2" - 12": Class 125 (125 psi at 400°F, 200 psi at 150°F), iron body, flanged, horizontal swing, vertical up-flow, bolted bonnet, renewable seat and disc in conformance with MSS SP71, type 1. Nibco 918, Grinnell 6300A, Watts 511, Crane 373, Hammond IR1124, Jenkins 624C, Stockham G931, or approved equivalent.
4. Silent Check Valve: 2-1/2" - 30", Class 125 (125 psi at 400°F, 200 psi at 150°F), flanged, ASTM A-126 Class B, cast iron body, bronze trim, resilient seat. Nibco F-910, Grinnell Series 500, Milwaukee 125 Class, Mueller 91-AP, or approved equivalent.

E. Gate:

1. 2" and smaller: Class 125 (125 psi at 400°F, 200 psi at 150°F), ASTM B-62 bronze, screw-in bonnet, rising stem, solid wedge in conformance with MSS SP80. Nibco 111, Grinnell 3010, Milwaukee 148, Hammond IB640, Watts 3100, Stockham B100, or approved equivalent.
2. 2-1/2" - 12": Class 125 (125 psi at 400°F, 200 psi at 150°F), ASTM A-125 Class B cast iron body, brass mounted, flanged, bolted bonnet, OS & Y, solid wedge, in conformance with MSS SP70. Nibco F-617, Grinnell 6020, Milwaukee F-2885, Hammond IR1140, Watts F503, Stockham 6623, or approved equivalent.

G. Globe:

1. 2" and smaller: Class 125 (125 psi at 400°F, 200 psi at 150°F), bronze, straightway pattern, screw-in bonnet, renewable seat and disc, in conformance with MSS SP80. Nibco 211, Grinnell 3210, Milwaukee 502, Hammond IB440, Watts 4000, Stockham B13, or approved equivalent.
2. 2-1/2" - 10": Class 125 (125 psi at 400°F, 200 psi at 150°F), iron body, brass mounted, flanged, straight way pattern, bolted bonnet, renewable seat and disc. Nibco F-718, Grinnell 6200, Milwaukee F-2981, Hammond IR116, or approved equivalent.

20 10 14 STRAINERS

A. General:

1. When two or more strainers of the same type are to be used in the same service, all strainers of this type shall be of the same manufacturer.
2. Only general strainer series are specified. Strainers shall have all options, trim, and accessories as specified whether or not listed as a prefix, suffix or the model number.
3. All manufacturers and models listed shall be considered as "acceptable manufacturers" and may be submitted without concern from subsection 150620.

B. "Y" Strainers:

1. 2" and smaller: ANSI 125 lb. (125 psi at 353°F, 200 psi at 150°F), ASTM B62 bronze body and straight thread cap, ASTM A240 304 stainless steel perforated sheetmetal with .033" openings for steam and 1/8" diameter for water service. Mueller 351M, Keckley F-150, Armstrong F4SC, Spirax/Sarco BT, Watts 777/777S, or approved equivalent.
2. 2-1/2" through 12": ANSI 125 lb. (125 psi at 353°F, 200 psi at 150°F), ASTM A126-B cast iron body and cover, ASTM A240 304 stainless steel perforated sheetmetal with .045"

openings for steam and ¼" diameter for water service. Mueller 751, Keckley A, Armstrong A-FL-125, Spirax/Sarco F-125, Watts 77F-D, or approved equivalent.

## **20 10 20 MISCELLANEOUS MATERIALS**

### **20 10 21 SLEEVES (NON-WATER PROOF, NON-FIRE RATED)**

- A. Piping passing through non-fire rated interior walls or floors shall be neatly field cut round holes with hole saws for non-masonry/concrete, and core drill for masonry/concrete. "Beating" an opening in a gypsum or masonry wall shall not be accepted.
- B. Install Schedule 40 pipe sleeves where pipes passing through floors of spaces where water could leak to the area below (i.e., mechanical rooms, janitor closets, kitchens, etc.). ID of pipe sleeve shall accommodate pipe insulation. Pipe sleeve shall extend a minimum of 4" above the finished floor, grout the annular space between the oversized core drill in the floor and the sleeve.
- C. In new construction, field formed walls or floors, the contractor shall install appropriate blocking or material or pipe sleeves.

### **20 10 22 WATER SEALS**

- A. All penetrations through interior to exterior walls or floors shall be sealed water tight using the methods below.
- B. In existing construction, holes shall be core drilled to the manufacturer's recommended size for the type and size of pipe to be sealed.
- C. The annular space between pipes/conduits and interior to exterior sleeves and sleeve penetrations for service temperatures below 250°F shall be sealed with GPT Industries "Link Seal" Model S-316 EPDM rubber with 316 stainless steel hardware. For service temperatures between 250°F-450°F and model "T" shall be used. Closure seals sizing shall be in accordance with manufacturer's data and application.
- D. The Contractor shall submit a schedule of sleeves and seals to the Architect/Engineer for approval indicating the following: carrier pipe size, location, type of sleeve - fabricated with dimensional details or purchased with manufacturer's support information, seal requirements - none, fire rated, non-fire rate or "Link Seal" with respective support data.
- E. Sleeves and seals manufactured by GPT Industries/PSI, Flexicraft Industries, Advance Products & Systems, Metraflex, or equivalent.

### **20 10 23 FIRESTOPS AND SMOKESTOPS, FIRE RATED/SMOKE PARTITIONS.**

- A. All penetrations through rated assemblies, walls, shafts, floors, roofs, etc., shall be firestopped in accordance with Local Building Codes, NFPA, U.L. Fire Resistant Directory, and manufacturer's instructions.
- B. Provide a FIRESTOP PRODUCT SCHEDULE consisting of the following minimum information:
  - 1. Type – indicate the type of materials, or system.
  - 2. Manufacturer – manufacturer's name, product name and product number.
  - 3. Mechanical System – indicate which Divisions 20 - 25 items the product is utilized for.
  - 4. Rating – indicate the fire rating and UL detail numbers.

- C. Submit the following with the above FIRESTOP PRODUCT SCHEDULE:
1. Manufacturer's specifications and technical data including installation instructions.
  2. Details of each proposed assembly.
  3. Manufacturer's representative who shall provide qualified engineering judgments and drawings for non-standard applications.
  4. Contractor's qualifications and related experience.
- D. Materials shall be stored per the manufacturer's recommendations and as specified for General Project storage in Division 20.

20 10 24 SEALS, NON-FIRE RATED

- A. All penetrations through non-rated walls, floors, etc., shall be sealed for draft stopping with caulk, putty, etc., designed for this use.

20 10 25 ESCUTCHEONS

- A. Wall, floor, and ceiling plates shall be spun brass, plain pattern, chrome plated, spring type or setscrew fastening. Provide escutcheons for all exposed piping in finished spaces.

20 10 26 FLASHINGS, CURBS, AND EQUIPMENT SUPPORTS

- A. Piping and other roof penetrations shall be flashed and/or pitch pocketed by the Contractor in a manner approved by the roofing contractor and specified herein.
- B. Single pipe and other round penetrations less than 12" O.D. diameter shall be flashed with Pate Pipe Seal or equal product, which consists of a spun aluminum base, a stepped rubber boot, and stainless steel adjustable clamps.
- C. Multiple pipe and other round penetrations less than 12" O.D. diameter shall be flashed with Pate Pipe Curb or equal product, which consists of a galvanized roof curb, thermoplastic cover, rubber boots, and stainless steel adjustable clamps.
- D. Pate type PHA pipe hood assemblies or equivalent product can be used at contractors' option for multiple pipes, refrigerant line sets, or irregular shaped objects entering the assembly horizontally. The faceplate the items pass through shall be neatly trimmed to the size of the items with gap not to exceed 1/4". Faceplate can be fabricated with horizontal seam through the penetration with an overlap to shed water. Caulk penetration air and watertight.
- E. When an irregular shaped member extends above the roof, a pitch pocket fabricated of galvanized or copper sheet metal material shall be provided. The vertical box portion shall extend a minimum of 4" beyond the contained pipe or member, have a solid bottom cut for the penetration and extend at least 6" above the finished roof. The collar portion shall extend a minimum of 9" beyond the vertical box and be fastened to the roof deck. The open space on the inside of the pitch pocket shall be filled with oakum and topped with a minimum thickness of 2" of pitch or roofing cement.
- F. Supports for roof mounted equipment piping, and ductwork shall also meet the requirements listed above. All roof supports shall be anchored to the structure in a manner that will transmit all loads including seismic and wind loads from the equipment supports through the roofing to the building structure. Equipment supports shall be equal to Pate model ES-1. Pipe/duct supports shall be equal to Pate model PRS-1. Curbs not specified with the equipment shall be equal to Pate Curbs. The finished height of the roof curb shall be 10" – 12" above the finished roof. The Contractors shall coordinate the curbs with the roof insulation thickness.



### 20 10 27 ROOF PENETRATIONS

- A. All roof penetrations shall be made in a manner that is consistent with the roofing installation and shall maintain the existing roof warranty. Coordinate with the roof warranty supplier as required.
- B. Supports for roof mounted equipment shall also meet the requirements listed in paragraph A. above. All roof supports shall be anchored to the existing structure in a manner that will transmit all loads including seismic and wind loads from the equipment supports through the roofing to the building structure.

### 20 10 28 ACCESS DOORS

- A. Access to mechanical equipment and ductwork of Divisions 20 - 29 required for testing, adjusting, inspection, maintenance or servicing shall be the responsibility of the Contractor. Doors for manufactured equipment shall be an integral feature included with the respective equipment. Access openings in ductwork shall be included with the fabrication in accordance with SMACNA practices.
- B. Openings in building components for access to concealed mechanical work shall be furnished by the Contractor and installed with the building construction work. Access doors shall be located as indicated on the Plans or as strategically required for inspection, maintenance, and service. The model and style shall fit the building construction, fire rating requirements and provide adequate size and function.
- C. Access doors shall be sized as shown on the drawings or shall be a minimum size of 18" x 18" and otherwise shall be large enough for purpose intended and shall be fabricated of heavy gauge steel frames and door panels with double action concealed spring hinges, 1/4 turn flush screwdriver operated cam locks and prime coat paint finish. Access doors for various applications shall be as follows:

<u>building construction:</u>	<u>Milcor access door:</u>
flush door in dry wall construction (walls and ceilings)	style DW
flush door in masonry or tile walls with exposed frame flange	style M (steel), Style MS (stainless)
flush door in plaster construction (walls and ceilings)	style K
recessed door in acoustical plaster ceiling	style AP
recessed door in suspended drywall ceiling	style CT (aluminum - wet locations)
flush door in suspended drywall ceiling	style CF (aluminum - wet locations)
door in suspended drywall ceiling	style ATR (fire resistive door)
fire rated separation (walls and ceilings) - fire rated door	
- D. Access doors are not required for Work above lay-in panel ceilings.
- E. Submittals shall indicate schedule of locations, sizes, types, adjacent building construction, finish, fire rating including thickness and type of insulation, conformance to UL requirements and associated labeling, metal and gauge of fabrication. Access door shall be as manufactured by Karp Associates, Milcor, or Higgins MfCO.

### 20 10 29 RESTRICTIONS, GENERAL FOR ALL PIPING SYSTEMS

- A. Do not use gaskets or packing containing asbestos.

- B. Selections of material and equipment and options for substitution shall conform to the requirements of Sub-section 20 00 60, MATERIAL and EQUIPMENT.
- C. "Bull head" tee connections are not permitted, unless approved by the Engineer.
- D. Close nipples and bushing reducers are not permitted.
- E. Slip joints are permitted in sanitary drainage systems only, on the fixture side of traps.
- F. Mitered elbows are not permitted in welded pipe construction.
- G. Solder for use in joints of copper piping for domestic (sanitary) cold water, hot water, hot water recirculating and softened water shall not contain lead.
- H. Unprotected, non-smoke rated plastic piping material is not permitted in above-the-ceiling spaces used as return air plenums, or exposed in any occupied space.
- I. Black and galvanized pipe, fittings, nipples and specialties are not permitted in water piping systems where copper and/or brass are the basic materials.
- J. Cast iron fittings are not permitted for gaseous distribution applications.
- K. Cast brass/copper fittings are not permitted for gaseous applications including refrigerant lines.
- L. Short radius 90-degree elbows and 180-degree returns are not permitted, unless specified and/or specifically noted.
- M. The use of pipe hooks, chain and perforated band iron are not permitted for hanging or supporting piping.
- N. Power driven inserts and attachments are not permitted unless approved by the Architect/Engineer on express request by the Contractor.
- O. Welded attachments to the structural steel of the building are not permitted unless otherwise noted or approved by the Architect/Engineer on specific request of the Contractor.
- P. Plastic pipe, fittings, valves and specialties are not permitted for gaseous distribution applications.
- Q. Plastic systems shall not be tested pneumatically.

### **20 10 30 JOINTS AND CONNECTION METHODS**

#### **20 10 31 THREADED**

- A. Threads for all screwed pipe systems shall be American National Standard taper threads in accordance with ANSI B-1.201.
- B. Threads shall be full, sharp, clean and free of fins and burrs. Pipe ends shall be reamed to remove internal burrs.
- C. Threaded connections shall be joined using teflon sealing tape applied to the male threads only.
- D. This sub-section does not apply to threads for compression, flare and sanitary drainage slip type drainage fittings.

- E. Threaded fittings for CSST shall be listed for use with CSST gas piping.

20 10 32 WELDED

- A. Welded joints shall be "V" type butt welds in accordance with ANSI B31.1.
- B. The Contractor shall only use welders regularly engaged in the piping trades and certified by the National Certified Welding Bureau, using procedures set forth in ASME Boiler Construction Code, Section IX, "Welding Qualifications".
- C. Contractor shall keep a copy of welder's certification on file at Contractor's office. Upon request the Architect/Engineer may request Contractor to produce certifications. Any pipe installed by a non-certified welder shall be removed if requested by Architect/Engineer.
- D. All steel piping shall be cleaned of mill scale and rust before assembly. Welds shall be chipped and hammered after each pass and joints shall be built up to at least the same thickness as that of the pipe wall. All welding shall be done in accordance with the welding procedures of the National Certified Pipe Welding Bureau conforming to the requirements of the ASA Code for Pressure Piping.
- E. Architect/Engineer shall have the authority to accept or reject the welds and require random samples of installed welds to be removed, tested and inspected.

20 10 33 GROOVED

- A. Grooved joints for grooved couplings and fittings shall be in accordance with accepted manufacturer's specifications and practices.
- B. Grooves may be cut or rolled in accordance with manufacturer's recommendations for type of pipe, sizes and thicknesses specified for respective systems.
- C. Gaskets shall be suitable for the temperature, pressure and compatibility with the fluid contained therein. Unless specifically specified otherwise or incompatibility with the system, gaskets shall be EPDM grade E.
- D. Grooved couplings shall be ASTM-A47 grooved malleable iron clamp type couplings as manufactured by Victaulic or equivalent.
- E. Grooved couplings for vibration isolation or as unions at equipment connections shall be similar to Victaulic Style 77; all others shall be similar to Victaulic Style 07.

20 10 34 SOLDERED

- A. Soldered connections shall be made in accordance with recommendations of the current edition of the Copper Tube Handbook of the Copper Development Association or as hereinafter specified.
- B. General criteria for soldered joints shall be as follows:
  - 1. Copper tubing shall be square-end cut by varied methods at the Contractor's option. The ends of the tubing shall be reamed to remove both internal and external burrs.
  - 2. Joints for copper piping for hydronic systems, domestic water, temperature controls, DWV systems and other applications of fluids below 250 degrees F. shall be soldered with 95-5 Tin Antimony. 50-50 Tin Lead solder shall not be used.

3. Cleaning of tubing and fittings, application of flux and heat, purging and cooling shall be in accordance with recommendations of solder and brazing alloy manufacturers for the joint type and material specified in the respective "PIPING MATERIAL SCHEDULE" in Section 230000.

#### 20 10 35 FLANGED

- A. Flanges shall be flat faced or raised faced as required for mating flanges of valves, specialties, equipment connections, etc.
- B. Carbon steel hex head machine bolts, ASTM A307, grade 2, with heavy hex nuts shall be used for joining 125 and 150# flanged joints, unless otherwise specified.
- C. Alloy steel machine bolts, studs and heavy hex nuts shall be used for joining of 250 and 300# flanged joints, unless otherwise specified.
- D. Lubricate the threads of bolts and studs with an acceptable commercial product. Include data with submittal for approval for piping material.
- E. Gaskets shall be 1/16" thick non-metallic type conforming to ANSI B16.21 and shall be suitable for the pressure and temperature of the fluid contained therein, shall be provided at all flange joints. Full-faced gaskets shall be used for flat face flanges; ring gaskets shall be used for raised face flanges.

#### 20 10 36 PLASTIC

- A. Solvent cement: Joints in PVC piping shall be made in accordance with manufacturer's guidelines and instructions for CPVC handling, joint preparation, type of primer and solvent/cement, curing time, temperature and testing.
  1. PVC pressure piping and DWV - solvent cement shall conform to ASTM D-2564 and primer shall conform to ASTM F-656.
  2. CPVC pressure piping - solvent cement shall conform to ASTM F-493.
- B. Gasket: Elastomeric seals (gaskets) for joining plastic piping shall conform to the following:
  1. PVC water distribution piping - AWWA C-900, ASTM D-2774 and ASTM D-3139.

#### **20 10 40 HANGERS, SHIELDS, SUPPORTS AND ANCHORS**

- A. General:
  1. All hanger devices (e.g. - concrete inserts, expansion anchors, clamps, pipe hangers, strut, etc.) shall be UL approved for the intended service. Material shall be applied within the load limitations prescribed by the respective manufacturer. Loads transmitted to the building shall be within the limitations of the structure.
  2. Acceptable manufacturers of hanger material are Anvil International, B-Line Systems, Inc., Tolco, PHD Manufacturing, ERICO/Michigan Hanger Co., National Pipe Hanger Corp.
  3. This section shall not apply to Division 21 Fire Protection.

#### 20 10 41 HANGERS

- A. Piping shall be supported from the building structure, walls, and floors. Piping shall not be supported from other piping, ductwork, conduits, etc. Loads shall be within the allowable load of building component that is connected to. Piping loads shall include, but not limited to, the

weight of the piping, valves, specialties, insulation, pipe covering, pipe content, pressure test media content, wind, snow, seismic, etc.

- B. Where piping is indicated on common trapeze hangers, racks, stanchions or brackets, the various trade contractors involved shall agree to a mutually acceptable arrangement among themselves, but each shall be responsible for the correctness and compliance of their work.
- C. Pipe hangers, supports, etc. for "cold" piping systems shall have hangers sized for the outside diameter of the insulation in order to maintain a continuous vapor barrier.
- D. Pipe hangers for all "ambient" and "hot" piping systems shall be the same size as the pipe, except at roller hangers or supports where the treatment shall be the same as for "cold" piping systems.
- E. Hangers, and other supports, anchors, guides, etc. in direct contact with copper piping material shall be copper plated. All others shall be electro-plated for indoor use and hot-dipped galvanized for outdoor use or in natatoriums and pool equipment rooms.
- E. The use of pipe hooks, chain, perforated band iron, wire, or cable are not permitted for hanging or supporting piping.
- G. Singular, horizontal, suspended piping above grade shall be hung with pipe hangers per the following schedule, unless noted otherwise:

<u>pipe sizes</u>	<u>piping application</u>	<u>Anvil International type and figure number</u>
3" and smaller	not subject to expansion/contraction	adjustable ring, #69
4" and larger	not subject to expansion/contraction	adjustable clevis, #260
4" and smaller	copper pipe/tubing	adjustable ring, #CT-99
5" and larger	copper pipe	adjustable clevis, #260 (1)
all	vertical risers	riser clamps
	steel	#261
	copper	#CT-121

- 1. hanger to be sized for outside diameter of insulation and to be used with insulation protection shield, figure 167.
- H. Hangers, supports, etc. shall position the piping properly in the work, and provide for expansion and contraction.
- I. Vertical piping shall be supported at each floor level with riser clamps bearing on the building structure or pipe sleeve.
- J. Pipe stands shall be field fabricated to meet the anticipated loads. The base plate shall be spaced 1" minimum above the finished floor with concrete or grout.
- K. Wall brackets shall be field fabricated to meet the anticipated loads. The minimum brace angle shall be 45° from the horizontal.

20 10 42 HANGER RODS AND HANGER SPACING

- A. Where "All-thread" rod is used it shall be galvanized, cadmium or zinc electro-plated. Where plain rod is used the threads shall be a minimum of 2" in length on each end.
- B. Hangers and hanger rod spacing for metallic piping shall be provided and installed in accordance with the Building Codes or the following schedule, whichever is more stringent:

<u>pipe size</u>	<u>rod diameter</u>	<u>max. hanger spacing</u>
1-1/4" & smaller	3/8" diameter	8' on centers
1-1/2" & 2"	3/8" "	10' oc
2-1/2" & 3"	1/2" "	10' oc
4" & 5"	5/8" "	12' oc*
6" & 8"	3/4" "	12' oc*
10" and 12"	7/8" "	12' oc*

\* cast iron pipe shall have a maximum spacing of 10' oc center with the hangers located near the joint.

- C. Hangers for non-metallic piping shall be spaced in accordance with the Building Codes or the following schedule, whichever is more stringent:

<u>pipe size</u>	<u>rod diameter</u>	<u>max. hanger spacing</u>
1" & smaller	3/8" diameter	4' oc
1-1/4" - 2"	3/8" "	5' oc
3"	1/2" "	6' oc
4"	5/8" "	7' oc
6" & larger	3/4" "	8' oc

20 10 43 ANCHORING

- A. Anchors for piping, ductwork, or equipment in new concrete construction may be suspended at the Contractor's option, or as shown on the plans, from inserts placed in the concrete as it is poured-in-place. Mechanical equipment rooms shall have inserts placed at a maximum of 4 ft. centers.

<u>hanger rod size</u>	<u>Grinnell insert figure number</u>
7/8" or smaller	single - CB universal, figure #282
7/8" or smaller	multiple - 1-5/8" x 1" continuous strut, #PS 449

- B. Anchors for piping, ductwork, or equipment in new concrete construction, existing concrete construction shall be suspended from epoxy resin set anchors, installed per the manufacturer's recommendations set into holes drilled into the concrete. Anchors shall be UL and/or FM approved, and applied within the allowable working load ratings for the respective size. Cataloged load values shall be derated by one third for seismic allowances. Minimum embedment depth shall be 2/3 of concrete thickness. Field pullout test shall be performed when requested by the Engineer. Anchors shall be Hilti type HVA.
- C. Anchors for piping, ductwork, or equipment in steel structured buildings shall be attached to the steel by bolting directly through the void in the bar joist chord or by using the appropriate cataloged type C-clamp or beam clamp. The roof deck shall not be used for supporting the piping or ductwork.
- D. Welded attachments to the structural steel of the building are not permitted unless otherwise noted on the Construction Documents or where approved by the Architect/Engineer on specific request of the Contractor.

- E. Power driven inserts and attachments are not permitted unless approved by the Architect/Engineer on express request by the Contractor.
- E. In all cases, anchor loading shall be based on hanger spacing, weight of the pipe to be supported when full and insulated, weight of any additional loads imposed upon the anchor, wind loading, seismic loading, quality of the material that the anchor is being installed in, etc. The Contractor shall verify in the field that the anchors used and the materials that they are being installed in are suitable for the load imposed and shall bring any problems to the attention of the Owner's Representative in writing immediately.
- G. Where anchors are loaded in shear in existing concrete structure, suitably sized and installed wedge type anchors may be used. Wedge type anchors shall be Hilti Kwik Bolt II.

20 10 44 SEISMIC RESTRAINT

- A. All materials and workmanship shall specifically comply with the above listed Building Code with respect to seismic requirements for the support and anchorage of all mechanical systems and equipment as installed on this project. Lateral forces to be restrained shall be as required by ASCE 7 Section 11 and 13 Architectural, Mechanical, and Electrical Components and Systems. Refer to structural drawings and/or Geotechnical Report for design values.

-Site Class (ASCE 7-05, Table 11.4-1 and 11.4-2):	D
-Occupancy Type	III
-Seismic Design Category	C
- Spectral Acceleration	
Ss	0.162
S1	0.094
Sds	0.172
Sd1	0.15

- B. All piping support and restraint details and practices shall conform to the publication "Seismic Restraint Manual Guidelines for Mechanical Systems" by SMACNA, 2008 Edition, and/or "Seismic Restraints" by B-Line systems, Inc.
- C. DELEGATED DESIGN: Design hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, herein referred to as Seismic engineer. Prepare drawings, calculations and details for any anchorage, bracing and/or sway bracing for seismic restraint as required by the local codes and Authority Having Jurisdiction. Seismic engineer shall inspect the final installation for compliance with the approved Seismic shop drawings. Seismic engineer to identify items that need to be corrected or changed and provide contractor additional/revised drawings as required.
- D. SUBMITTALS:
  - 1. SHOP DRAWINGS: Submit drawings, calculations and details shall be signed and sealed by a Professional Engineer licensed in the State of the Project's location.
  - 2. CLOSEOUT: As-built seismic drawings with Letter from Seismic engineer stating that the completed installation meets the design.
- E. INSTALLATION: Contractor shall only use those materials submitted and approved. Contractor shall notify Seismic Engineer when actual installation differs from the approved Seismic shop drawing.

## **20 10 50 BASIC MECHANICAL METHODS - GENERAL**

### 20 10 51 INTENT OF PROJECT DOCUMENTS

- A. Install the Work in accordance with the Project Documentation and considerations enumerated in Subsection 20 00 01, GENERAL (Project Documents).

### 20 10 52 ARRANGEMENT OF WORK

- A. All Work shall be arranged so that hangers and supports for the mechanical equipment and materials shall be within the load limitations of the structure and the respective hanger and/or support.
- B. Contractor shall not scale from drawings to determine the exact locations for devices, piping, ductwork, etc., but shall follow the architectural drawings, the structural drawings and the actual building conditions, in establishing dimensions and lines of run. The work shall be adjusted to accommodate interferences anticipated and encountered. The Contractor shall verify the exact material quantities and lengths required.
- C. Piping that is required to pitch shall have priority over piping that does not pitch. Work which cannot be changed in elevation shall have priority over that which can be moved. Offsets, transitions and changes in direction shall be made in piping and ductwork to maintain headroom and pitch whether or not indicated on the Plans. The Contractor shall provide air vents, traps, dirt legs, drains, lifts, sanitary vents, mechanical vent lines, etc. as required to install the mechanical systems for proper operation and maintenance.
- D. Do not install work in the immediate proximity of electrical components (e.g. - panels, switches, controls, boxes, etc.) in equipment rooms. Drip pans above and/or around electrical equipment are not permitted.
- E. Aluminum and copper products shall not be encased in concrete.
- E. Work in "finished spaces" shall be concealed within walls, chases or above the ceiling unless specifically indicated otherwise. Install the Work to coordinate with other trades and to conform to the architectural reflected ceiling plan.
- G. The work shall be installed parallel with the building lines unless specifically shown or noted otherwise.

### 20 10 53 COORDINATION

- A. It shall be the Contractor's responsibility to coordinate their work with the work of other trades, and with the architectural and structural drawings. Where physical interferences cannot be resolved between the trades, or when encountered in the field, the Contractor shall prepare composite drawings at a scale of not less than 3/8" = 1'-0" clearly showing the Work of Divisions 20 - 29 in relation to the Work of others to identify the conflict. Submit a proposed resolution to the Architect/Engineer for approval in accordance with Sub-sections 20 00 01, GENERAL (Project Documents) and 20 10 06, SUBMITTALS.
  - 1. Do not proceed with Work in question until the matter is mutually resolved among the involved parties, and adequate information has been submitted to the Architect/Engineer for review. No additional compensation shall be granted for modifications and execution of the resolution(s). Modifications are to be incorporated in the "as-built" drawings.



- B. Contractor shall review the Project Documents, site conditions, and the requirements of other disciplines, and shall report any discrepancies between them to the Architect/Engineer and obtain from him written permission for changes necessary in the Mechanical Work. Subsequent clarification(s) by the Architect/Engineer will not be a change in scope of the Work. The Contractor at no addition in the contract price shall perform any such modifications required.
- D. Contractor shall verify tie-in locations to verify sizes, direction of flow (via pressure or physical tracing, not labels), materials, elevations, etc. prior to commencing new work. Contractor shall notify Architect/Engineer upon discovery of discrepancy. Work performed prior to verification will be corrected at no cost to Owner.
- E. The drawings shall not be scaled; obtain detailed information, shop drawings, installation and maintenance bulletins, etc. to determine exact requirements and to satisfactorily achieve the intent of the Project Documents.
- F. The Contractor shall furnish and properly install all sleeves, slots, chases, openings, recesses, supports, anchors and anchor bolts required for his Work in coordination with the other trades as the building is erected.
- G. The expenses for changes required by neglect in executing, coordinating or scheduling the Work properly or avoiding conflicts shall be borne by the Contractor precipitating the issue requiring the changes.

#### 20 10 54 DELIVERY, STORAGE AND HANDLING

- A. Delivery, storage and handling of equipment and material are the Contractor's responsibilities. The Contractor shall perform the Work in accordance with the following criteria:
  - 1. Delivery shall be arranged by the Contractor (including Owner furnished items) for the expeditious and economical pursuit of the Work and to meet the scheduling requirements of the Contract.
  - 2. The Contractor will be assigned a "lay-down" area at the job site and shall confine temporary storage to this area.
  - 3. The Contractor may take delivery of equipment and material at his "shop" or an off-site location as suits the performance and schedule of the Work.
  - 4. Regardless of where and how equipment and material are temporarily stored prior to installation, or if installed at the job site prior to acceptance, the Contractor is responsible for the following:
    - a. All equipment and material shall be accessible to the Architect/Engineer for inspection.
    - b. All equipment and material shall be protected adequately and properly from the weather, dirt and water, chemical, mechanical or comprehensive damages.
    - c. The Contractor shall be liable for the repair and/or replacement (including labor) of any equipment and material lost, damaged or defective prior to acceptance.
  - 5. The Contractor shall arrange all labor, tools, services and scheduling to perform the handling of equipment and material for his Work.

#### 20 10 55 GENERAL CLEANING

- A. Each Contractor and Subcontractor shall be responsible for progress and final clean-up of his respective Work in accordance with the Contract Documents, requisite ordinances and regulations. Clean-up and legal disposal of debris from the Work, excess refuse and presence at the job site shall be performed in a timely and satisfactory manner. If not, the Contractor shall

be notified of the unsatisfactory condition. If the matter persists, the Contractor will be back charged for the clean-up performed by others.

- B. Clean exposed exteriors and limited access interior surfaces of all equipment, piping and ductwork of foreign matter to provide an "as new" condition.

#### 20 10 56 CLEANING OF PIPING SYSTEMS

- A. The Contractor shall clean the respective piping system(s) that are included in his scope of work. All systems shall be flushed with water or air (depending on ultimate use) to relieve any congestion and internally cleanse the respective piping system. The Contractor shall provide all flushing media in sufficient quantity, inlet connections, discharge or drainage outlets and any temporary provisions to protect components, or remove it, to facilitate the flushing. Clean and replace all strainer screens and filters. Flush clean and drain all low points in the piping.
- B. Owner's representative shall be present for flushing, cleaning, and rinsing. Water treatment representative must check water after rinsing to insure all chemical cleaner has been removed and the Alkalinity of the rinse water is equal to that of the make-up water.
- C. All pipe systems for hydronic applications shall be flushed continuously with 100% city water make-up until the water runs clean from all drain locations. Each piping system shall be subsequently cleaned with recommended dosage of an approved pre-cleaning chemical designed to remove deposition such as pipe dope, oils, loose rust, mill scale and other extraneous materials for a minimum period of twenty-four (24) hours then drained, refilled, and rinsed clean. Flushing before and rinsing after cleaning shall be supplying constant make-up water while draining at all system low points and drains.
- D. Steam and condensate return piping shall be flushed continuously with 100% city water make-up until the water runs clean from all drain locations. Each piping system shall be subsequently cleaned with recommended dosage of an approved pre-cleaning chemical designed to remove deposition such as pipe dope, oils, loose rust, mill scale and other extraneous materials for a minimum period of twenty-four (24) hours then drained, refilled, and rinsed clean. Flushing before and rinsing after cleaning shall be by supplying constant make-up water while draining at all system low points and drains.
- E. New or repaired potable water systems shall be purged of deleterious matter and disinfected prior to utilization. The method to be followed shall be that prescribed by the health authority having jurisdiction or, in the absence of a prescribed method, the procedure described in either AWWA C651 or AWWA C652, or as described in this section. This requirement shall apply to "on-site" or "in-plant" fabrication of a system or to a modular portion of a system.
  1. The pipe system shall be flushed with clean, potable water until dirty water does not appear at the points of outlet.
  2. The system or part thereof shall be filled with a water/chlorine solution containing at least 50 parts per million (50 mg/L) of chlorine, and the system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing at least 200 parts per million (200 mg/L) of chlorine and allowed to stand for 3 hours.
  3. Following the required standing time, the system shall be flushed with clean potable water until the chlorine is purged from the system.
  4. The procedure shall be repeated where shown by a bacteriological examination that contamination remains present in the system.
  5. Water quality acceptance test(s) required shall include: Total Coliform, e-coli, pH, Alkalinity, Turbidity. Test potable water from nearby source as a reference sample.

## 20 10 57 PRESSURE TESTING

- A. The Contractor shall submit a schedule at the beginning of the Work of the piping systems that are to be pressure tested, and indicate whether tests will be for an entire or partial system. Entire piping systems shall be pressure tested at one time unless it is not possible or practical.
- B. All piping to be insulated or concealed shall be pressure tested prior to the application of the insulation or concealment.
- C. A representative of the Architect/Engineer shall witness all pressure testing. The Contractor shall notify the Architect/Engineer at least three (3) days prior to the test date.
- D. Each piping system shall be tested per the method, test pressure, and test duration as specified in the Piping Material Schedules.
- E. The Contractor shall provide all test media, measuring devices, inlet connections, test measurement connections, and disposal of test media. The Contractor shall protect, isolate and/or remove piping system components that can not be subjected to test pressures.
- E. Hammer each joint in welded or soldered piping while under test. Leaks shall be repaired and the test(s) repeated until the respective piping system is tight.

## **20 10 60 BASIC MECHANICAL METHODS - INSTALLATION**

### 20 10 61 GENERAL

- A. The Contractor shall install all equipment and material as specified in the Project Documents. The Contractor shall review the installation requirements, and provide all of the appurtenances and accessories required for complete systems and a functioning installation. The Contractor shall be prepared to submit installation details and procedures where specified or requested for approval by the Architect/Engineer.
- B. The Contractor shall follow the manufacturer's instructions for the handling, temporary storage, protection and installation of the respective equipment and material. The Contractor shall promptly notify the Architect/Engineer in writing of any discrepancy or conflict between the Project Documents and the manufacturer's instructions, and request clarification. Unless there is a specific change in the scope of work, no additional compensation shall be granted for modification(s) and execution of the clarification.
- C. Work performed that does not comply with the manufacturer's instructions, any approval or instructions from the Architect/Engineer, or that causes a significant and/or unapproved deviation from the intent of the Project Documents shall not be grounds for additional compensation for costs to modify the Work in a manner directed by and to the satisfaction of the Architect/Engineer.
- D. All Work shall be installed to permit access and/or removal of components (e.g. - coils, fan wheels and shafts, filters, guards, bearings, motors, mechanical drives, etc.) that require periodic maintenance, servicing, repair and/or replacement. Equipment, piping, ductwork, conduit and raceways shall be arranged to permit access to valves, motors, motor and temperature controls, and to clear the opening of doors and access panels.
- E. Welded attachments to the building structure are not permitted.

20 10 62 PIPING

- A. All piping shall be properly installed and supported with adequate provisions for clearance from other work, for expansion, contraction, slope, anchorage and prevention of transmission of vibration.
- B. Piping shall be generally installed parallel to building lines in the most expeditious and economical manner and to facilitate servicing. Piping shall be positioned and installed to provide noiseless circulation, and pitched to provide drainage and avoid air pockets. Valves and specialties shall be located to provide proper function and be readily accessible for servicing and maintenance.
- C. All piping connecting to equipment shall be installed without springing and any strain at final connections. The Contractor may be requested to disconnect piping to demonstrate that the piping has been so installed.
- D. Steel piping connections to equipment with rotating or reciprocating components shall be provided with a minimum of two grooved clamp type couplings per piping connection, which shall be Victaulic Style 77 couplings or equivalent. Copper piping connections to equipment with rotating or reciprocating components shall be provided with Mason Industries SafetyFlex model SFDEJ flexible joint. Air handling units with internal fan isolation are not included in the above.
- E. Changes in direction in the piping shall be made with manufactured fittings only. All elbows shall be long radius (1.5 x diameter) unless specifically noted otherwise. Bending may be permitted on submittal for approval of a satisfactory procedure to the Architect/Engineer for approval. Bending is to be accomplished with hydraulic type equipment producing no malformations in the piping.
- F. Full size branch connections and branch connections one size smaller in steel piping shall be made with manufactured fittings only. Branch connections two sizes and smaller than the main run may, in special cases with the Engineer's written permission, be made with manufactured fittings, weld-o-let or thread-o-let type fittings for welded piping construction, saddle type fittings for grooved piping construction or a pipe-to-pipe nozzle weld. Small branch connections for thermometers, pressure gauges, controls, etc. may be made with nozzle welded 3000# forged steel threaded couplings, thread-o-lets or saddle fittings. For insulated piping, provide branch connections with sufficient "neck" length to extend beyond the thickness of the insulation.
- G. Changes in direction in piping systems using hard temper copper tubing shall be made with manufactured and cataloged elbow fittings. Branch connections and reductions in all copper tubing systems shall be made with tee and reducer fittings. At the Contractor's option, utilizing a "Tee Turner" tool and corresponding procedure may provide branch connections. These joints shall be brazed and not soldered.
- H. Minimum slope for piping shall be provided in accordance with the following schedule, unless otherwise specified, noted or shown:

Type of Piping Fluid Conveyed	System Component	Pitch	Direction of Fall
Sewer, sanitary	main/branch	1/8"/Ft.	w/flow
Sewer, storm	main/branch	1"/40/Ft.	w/flow
Steam	main	1/8"/Ft.	w/flow
Steam	branch	1/8"/Ft.	to main or drip
Steam condensate	main/branch	1/8"/Ft.	w/flow
Chilled/heating water	supply/return main	1"/40Ft.	from vent
Chilled/heating water	runouts to risers	1/8"/Ft.	back to mains

Condensate drain	1"/20Ft.	w/flow
Domestic water	1"/40Ft.	to drain

- I. All piping materials shall be physically cleaned internally and externally of mill scale, oxidation, grease, oil, dirt, mud, loose and foreign matter before fabrication and installation.
- J. All open ends of piping and equipment shall be closed during fabrication and installation to keep dirt and foreign matter out of the Work.

#### 20 10 63 VALVES

- A. Shut-off valves shall be provided at all inlet and outlet connections to equipment, at major branch connections to mains, where required for normal service, and where shown on the drawings, flow diagrams or details.
- B. Valves shall be the same size as the adjacent piping, except for control valves furnished in Division 25.
- C. Valves shall be accessible and free from interference when operated. Valves shall be installed with the stem on or above horizontal. Globe valves shall be installed with pressure under the seat. Butterfly valves shall be free to open and close without obstruction.
- D. Valves shall be packed and glands adjusted before final acceptance.
- E. Underground valves not installed in accessible manholes/vaults shall be provided with curb stop valve box.
  - 1. Valve box shall be heavy duty cast iron, cast iron lid, 1.5 mills bituminous coated, two piece screw type, lettering matching the service of the valve (i.e. water, gas, etc.) , Equal to Tyler Union 29U 6850.
  - 2. Valve box shall be installed flush with final finished grade. Install with a 16" Sonotube around the valve box and the annular space filled with 3/4" clean rock up to 12" subgrade. Contractor shall ensure the valve box is plum and square as part of the installation. Owner's representative will witness valve operation and curb stop box installation for acceptance. Valve boxes that do not pass acceptance shall be corrected at the contractor's expense, until it does pass.

#### 20 10 64 EQUIPMENT

- A. The Contractor shall furnish and install the necessary frames, stands, brackets, stiff-legs, hangers, etc. to support or suspend the equipment and material that require this installation arrangement. The Contractor shall be responsible for the size, quantity, location and design of the supports and suspensions. The design shall permit no deflection of the support, the suspension arrangement or related building members, nor impart any vibration into the building structure. Loads transmitted to the building shall be within the limitations of and distributed satisfactorily to the structure. Designs for supports and suspensions shall be submitted for approval to the Architect/Engineer. Any attachment to the floor shall be provided with a minimum of 1" thick concrete or grout between the base and the floor. All associated ferrous metal parts shall be painted or galvanized. Painting shall consist of one (1) coat of base primer on properly prepared surfaces and one (1) coat of rust inhibiting enamel, color selected by the Architect/Engineer.
- B. Each exposed mechanical drive and rotating shaft shall be provided with a protective guard. The guards may be provided with the respective equipment or may be field fabricated. The guard shall be constructed to comply with the appropriate safety requirements of the National

Institute of Safety and Health and OSHA. Provide adequate and proper access for speed measurements for all rotating shafts. Guards shall not interfere with the lubrication of equipment nor restrict the airflow into fan inlets. The design for field fabricated guards shall be submitted for approval to the Architect/Engineer.

- C. All equipment except pumps, having rotating or reciprocating components shall be provided with captive spring type vibration isolation mounts for seismic and restrained service. Mounts shall be selected at a maximum transmissibility of 0.03 (isolation efficiency of 97%) at the lowest anticipated operating speed of the equipment.
- D. Grease fittings for bearings shall be extended to accessible locations.
- E. Installation Instruction
  - 1. Equipment shall be set level, plumb, properly oriented, aligned and secured in the location shown on the drawings.
  - 2. Shims used for leveling shall be of size sufficient to cover the entire bearing surface except where shims are used to level preparatory to grouting. Shims used in conjunction with grouting shall be located to properly support equipment at load points to prevent any distortion.
  - 3. Assembly and installation of the equipment shall be in strict compliance with the equipment vendor's instructions.
  - 4. Where specified, equipment shall be assembled, installed, inspected and adjusted under the supervision of the Vendor's representative.
  - 5. Lugs, saddles, supports, covers or similar components which have been shipped separately or loose shall be located and attached by the Contractor by means of welds or bolting.
  - 6. Holes in structural steel required for installation of equipment shall be drilled as required.
  - 7. Contractor shall supply and install self-anchoring anchors.
  - 8. The Contractor shall grout under the equipment to effect a firm permanent setting as required.
  - 9. Upon completion of installation the Contractor shall remove all staging, blocking and construction debris from the equipment.
  - 10. The Contractor shall check all packaged or pre-assembled equipment to make sure that all packing shims and blocking is removed before rotating, running or testing the equipment.

E. Equipment Alignment

- 1. The Contractor shall do a cold final alignment of all rotating equipment shafts and coupling assemblies even when they were factory aligned. The reverse dial indicator method of alignment is preferred whenever possible. The following requirements apply to alignment:
  - a. Initial Alignment shall be checked with all piping larger than NPS 1" disconnected from the equipment. Maximum misalignment readings shall be 0.05-in. total indicator reading (TIR) on the rim and on the face of the coupling hub for all equipment unless otherwise noted in the Equipment Data Sheet instructions. Equipment shall rotate freely, all bolts shall be tight, all bearings and couplings shall be lubricated, and all safety guards shall be in place.
  - b. Soft Foot. Equipment will be checked for "soft foot". If the dial indicator indicates more than 0.05 in. (TIR) when any equipment to baseplate bolt is loosened, the equipment will be reshimed.
  - c. Final Alignment. The Architect/Engineer will witness the final alignment check on each piece of rotating equipment. Connecting pipe shall fit up to the equipment without the use of mechanical force. Connecting piping greater than NPS 1" will be

bolted to the equipment one at a time, with the dial indicator attached. If the alignment changes by more than 0.05 inches (TIR), the piping will be revised until the alignment change is acceptable.

2. Shims used for aligning the equipment shall be stainless steel and shall be stamped with the shim thickness. The shim shall be large enough to cover the complete load bearing area and the total height shall be a maximum of 1/8 inch and shall be installed between the equipment's foot and the equipment's baseplate.

## 20 10 65 MISCELLANEOUS

### A. Sleeves, inserts, etc.

1. The Contractor shall furnish and properly install sleeves, inserts, supports, anchors and anchor bolts required for his Work. The size, quantity and location of chases, openings and recesses in the building structure shall be the responsibility of the Contractor performing the Work that requires these considerations. Patching of oversized openings and finishing thereof shall be the responsibility of the trade or Contractor requiring the opening. Material and labor for openings in new construction requiring structural framing including lintels and angles shall be furnished by the trade requiring the opening and installed by the General Contractor. Lintels shall be structural steel angles, channels, or tees of proper size and sections for the load supported.
2. Sleeves shall be provided for all penetrations through the building structure. Sleeves through floors shall extend 1" above the finished floor except where otherwise noted; sleeves through walls, partitions or structural members shall be flush with the exterior surface on both sides. Sleeves shall be sized to include the pipe/duct insulation.
3. The space between the sleeve (or opening in the structure) and the pipe/duct or outside of the insulation of penetrations through fire rated components of the building shall be fire stopped, see Section 20 10 20 Miscellaneous Piping Materials. Penetrations through non-rated components of the building shall be draft stopped, see Section 20 10 20 Miscellaneous Piping Materials.

### B. Unions and flanges:

1. A ground joint type union shall be provided in threaded and sweat joint piping, 2" and smaller pipe or tube size, down-stream of each branch shut-off valve, control valve and specialty item, the inlet and outlet connections of each piece of equipment, and where shown on the drawings.
2. Flanged connections shall be provided in piping 2-1/2" and larger at each manual valve, control valve, specialty item and the inlet and outlet of each piece of equipment.

- C. Interconnections between dissimilar piping material systems shall be made with fittings manufactured for the specific application.

## **20 10 70 BASIC MECHANICAL METHODS - RELATED WORK**

### 20 10 71 DEMOLITION

#### A. Work Included:

1. The Contractor shall legally dispose of the designated equipment, apparatus and/or piping. Any cost of removal or salvage value shall be credited to the Contractor's account and shall be considered accordingly in the Contractor's bid.
  - a. Recovery and reclaim of refrigerant shall be performed by the Contractor in accordance with EPA regulations. The Contractor shall submit to the Owner a

certificate stating the names and license numbers of the personnel performing the removal of the refrigerant, the machine and serial number of the reclaim equipment used, type and quantity of reclaimed refrigerant, and all other required data.

- b. The Contractor shall return to the Owner for his use the reclaimed refrigerant in cylinders.

B. Work Not Included:

1. The removal and disposal of asbestos based insulation or other hazardous materials applied to, or contained in, the mechanical equipment, material and piping designated to be demolished shall not be included in the scope of the work regardless if known ahead of time or discovered in the course of performing the Work. In the latter case, the Contractor shall notify the Architect/Engineer and shall not pursue that portion of the Work until others have removed the asbestos-based material. The removal and disposal of asbestos-based material shall be arranged by and to the account of the Owner, and conducted separately from the demolition work.

C. Miscellaneous:

1. Loose ends of mechanical systems shall be capped and/or sealed in a safe and secure manner approved by the Architect/Engineer.
2. Dead legs of branch piping are not permitted unless a cap is specifically shown on the drawings. Where a cap is not shown and the drawings indicate to cap piping, the Contractor shall remove branch piping back to the main and cap at that point.

20 10 72 CUTTING AND PATCHING

- A. The basic premise of this Sub-section is that the cutting and patching (where required) are performed in existing building components. In "new" construction, the premise is that the building component is already in place.
- B. The Contractor requiring the penetration of or the access way in the building structure to fulfill the intent of the Project Documents for his Work shall be responsible for the cutting and the subsequent patching in accordance with the following criteria:
  1. No structural component of the building shall be cut or violated without express approval of the Architect/Engineer.
  2. The Contractor shall verify the presence of any concealed utility or service within the structure (walls, roof, floor, etc.) in question, and shall be responsible for maintaining continuity and/or replacing it.
- C. Cutting of work-in-place in "new" construction because of error, neglect or damage inflicted shall be the responsibility of the Contractor precipitating the issue.
- D. "Patching" shall be construed as the repairing or replacing of the building structure to return it to an original or new condition, in the opinion of the Owner and/or Architect/Engineer, as existed prior to the cutting.
- E. Patching and finishing work shall be the responsibility of the Contractor requiring the cutting. The patching shall match all the substantive and visual aspects of the structure and adjacent surfaces. Restoration and finishes shall be as specified and executed in the respective sections, schedules and/or details of the Project Documents for the general construction work. Completed work and any special requirements shall be subject to approval by and satisfaction of the Architect/Engineer.



## 20 10 74 CONCRETE WORK (CAST-IN-PLACE)

### A. General:

1. This sub-section shall supplement Section 03300 – Concrete Work for the concrete work required to install the work of Divisions 20 - 25.
2. In the event of a conflict between this sub-section and Section 03300, the more stringent shall apply.

### B. The Contractor shall include the following Work:

1. Provide concrete foundations, bases and/or housekeeping pads for mechanical equipment furnished in his respective scope of work where such are not indicated on the architectural or structural drawings. Concrete work shall include requisite excavation, formwork, reinforcing and contained hardware.
2. Submit for approval to the Architect/Engineer detailed and dimensioned drawings of size, location, reinforcing and hardware contained therein of concrete work to be provided.

### C. Housekeeping Pads:

1. All equipment setting on concrete or other type of pave flooring shall be set upon a raised “housekeeping” pad, unless noted otherwise.
2. The Contractor shall be responsible for this size, location, and any required anchor bolts. In general, housekeeping pads shall be a minimum of 3 ½” high, a ¾” chamfer on exposed corners and edges, and a minimum of 3” beyond the equipment on all sides or as required for anchor bolt edge distance.
3. Housekeeping pads shall be 3000 psi 28-day compressive strength concrete. Pads shall be reinforced and doweled to the floor slab. Refer to ASHRAE-A Practical Guide to Seismic Restraint 1999, Chapter 6 – Housekeeping Pads for size and spacing of reinforcing and dowels.
4. Specifically designed vibration isolation/inertia concrete bases for equipment will be specified and shown separately.

## 20 10 75 PAINTING

### A. General:

1. This sub-section shall supplement Section 09900 – Painting for the painting work required for the work installed by Divisions 20 - 25.
2. In the event of a conflict between this sub-section and Section 09900, the more stringent shall apply.

### B. Painting of the following shall be included in the scope of work of this sub-section:

1. All rooftop equipment (plenums, fans, etc.) to be painted to match the adjacent building.
2. All mechanical equipment including housings, fans, etc., not factory painted shall have prime coat and finish painting.
3. All plain steel hanger rods, plain steel pipe hangers, field fabricated or prefabricated steel supports and braces, and other ferrous metal. Prime coat only for all interior work, both exposed and concealed. Prime coat and finish painting of all exterior work.
4. Touch-up, as required, of factory finished equipment to original condition.
5. Interior surface of air ducts, cabinets, enclosures, covers and air dampers where visible from a finished space through grilles and louvers with one coat of flat black paint.

6. All above grade exterior uninsulated piping systems shall have a prime coat and finish painting.
- C. Painting of the following shall not be included in the scope of work of this Sub-section, unless noted otherwise:
1. Surfaces to receive special finishes specified elsewhere.
  2. Building construction surfaces - floors, ceilings, interior and exterior walls, exposed concrete work, special finishes, etc.
  3. All stainless steel, brass, copper, aluminum, plastic, electro-plated and galvanized surfaces.
  4. Caulking, sealers, fire stops, etc.
  5. Valves, controls, specialties.
  6. Nameplates of equipment. Replace nameplate if painted.
  7. Light fixtures.
  8. Equipment (mechanical and electrical) which has been finished in a factory.
  9. Black steel surfaces over 250 degrees F. (e.g. - breechings, kitchen hood exhaust ducts, etc.).
- D. General Requirements:
1. The Contractor shall provide all labor, coating materials, accessory materials (e.g.- turpentine, painting thinners, etc.), tools and services necessary and reasonably incidental to the scope of work of Sub-section 20 10 75.
  2. Coatings shall be factory prepared and mixed; ready for application upon delivery; have good flow and brushing properties and be capable of drying and curing free of streaks or sags.
  3. Materials for each application shall be compatible with one another and with other specified materials with which contact may be made.
  4. Products shall meet the following UL fire hazard classifications when tested in accordance with ASTM E84: Flame spread, 0; Fuel contributed, 5; Smoke developed, 15.
  5. Coatings shall be applied in accordance with the paint manufacturer's recommendations with the surfaces well illuminated. In general, coatings shall not be applied when the relative humidity is above 60% nor the ambient temperature below 45 degrees F.
  6. The Architect/Engineer shall make color selections, when required.
- E. Acceptable Manufacturers
1. Benjamin Moore & Co.
  2. Porter International
  3. Pratt & Lambert, Inc.
  4. Sherwin Williams Co.
  5. Glidden
  6. Pittsburgh
- F. The Contractor shall submit the following to the Architect/Engineer for review and approval:
1. Statement of qualification that the company specializes in commercial painting and finishing with a minimum of five (5) years experience.
  2. Product data describing the following:
    - a. Instructions for substrate preparation including priming.

- b. Instructions for product preparation, application procedures, clean-up and maintenance.
    - c. .Recommended ambient temperature and relative humidity range, substrate temperature, moisture content and alkalinity at the time of application.
    - d. Manufacturer's list of trademarked products for each coat of each system. For each product, state vehicle type, percent solids by volume, method of application, drying time, recommended rate of coverage and dry film thickness for each coat. Coordinate with the Schedule in Sub-section in 20 10 75.84.
    - e. Advise any recommendations which differ from the specified or scheduled requirements.
  3. Material Safety Data Sheet (MSDS) for each coating and painting product, and maintain a file of it at the job site for reference and emergency use.
  4. Certificates and/or test reports demonstrating that the painting products specified meet regulatory requirements.
  5. Color charts and available sheens of finish, when required, for selection by the Architect/Engineer.
  6. Samples of painting products when requested for inspection by the Architect/Engineer.
- G. Painting:
  1. The Contractor shall be responsible for delivery, handling and storage of all coating and painting materials for the pursuit of his work.
    - a. All painting products shall be delivered in sealed containers.
    - b. All painting product containers shall be labeled to show the manufacturer's name, type of coating, brand name, coverage, surface preparation, drying time, clean-up, color designation and instructions for mixing and reducing.
    - c. All painting products shall be handled and stored in accordance with the respective manufacturer's recommendations. In the absence of specific instructions, products shall stored in well-ventilated areas at a minimum ambient temperature of 45 degrees F. and a maximum temperature of 90 degrees F.
    - d. Precautions shall be exercised to prevent fire hazards and spontaneous combustion. Provide adequate type and quantity of fire extinguisher at the job site.
  2. The Contractor shall perform the following in preparation of the painting application:
    - a. Verify that surfaces and substrate conditions are ready to receive the application of coatings as specified or in accordance with manufacturer's recommendations. Commencement of application is acceptance of existing conditions.
    - b. Provide drop clothes and other protective measures to prevent coatings on other work not included in the scope of work of this sub-section.
    - c. Where required by Architect/Engineer, post "WET PAINT" signs.
    - d. Solvent or power tool clean surfaces, as required or as deemed appropriate, to remove grease, scale, dirt, rust, mill scale, weld splatter and burrs. Apply primer immediately after cleaning.
  3. Application:
    - a. Coating products shall be prepared and applied in accordance with the respective manufacturer's instructions and reviewed submittals. Dry mil thickness of each coat shall be as scheduled or as recommended by the manufacturer. Finish coat shall not be less than 5.0 mils in thickness, and sufficient to cover completely substrates and undercoats.
    - b. Where shop prime coat finishes are specified elsewhere, primer may be omitted, except as otherwise scheduled, specified or recommended by the coating

manufacturer. Damaged shop prime coats shall be touched-up, using a primer compatible with or same as original primer.

- c. Each coat shall be applied to provide a uniform finish, without sags, laps, brush marks or other defects. Allow applied coat to dry before next coat is applied.

4. Schedule - Latex, General Painting Materials:

- a. Steel - unprimed, located indoors or outdoors:  
One (1) coat lead and chromate free alkyd primer. Two (2) coats latex, semi-gloss.
- b. Steel - shop primed, located indoors or outdoors:  
Touch-up with lead and chromate free alkyd primer.  
Two (2) coats latex, semi-gloss.
- c. Insulation on mechanical equipment, located indoors:  
One (1) coat latex primer sealer.  
Two (2) coats latex, flat.

20 10 76 LUBRICATION

- A. Provide all oil and grease for the operation of all equipment until acceptance. The Mechanical Contractor and Subcontractors shall be held responsible for all damage to bearing while the equipment is being operated by them up to the date of acceptance of the equipment. Protect all bearings during installation and thoroughly grease steel shafts and other unpainted steel surfaces to prevent corrosion. All motors and other equipment shall be provided with covers as required for proper protection during construction. For equipment that is received void (dry) of lubrication the Contractor shall lubricate the equipment before storing to prevent internal damage to the equipment.
- B. After the Contractor moves on site, they shall hand rotate all existing rotating equipment at least once every week in order to make sure the equipment remains free and eliminate the risk of including a permanent set in the rotating shaft or bearing.

20 10 77 DRAINING, FILLING AND VENTING SYSTEMS

- A. The Contractor shall provide all required labor for draining, filling and venting of new or modified systems as many times as required during construction and for all phasing activities.
- B. Where draining and filling systems affects other systems or the Owner's normal operations, then they shall be scheduled at least 1 month in advance with the Owner and shall be carried out to minimize such disruptions.

**20 10 80 TESTING, ADJUSTING AND BALANCING**

20 10 81 GENERAL

- A. TAB During Construction: First choice is to have TAB provided by MU Campus Facilities Energy Management (EM). For TAB provider other than EM and PM shall work together to select consultant that is best suited to meet project needs.
- B. Testing for current (preconstruction) performance prior to system modification is required during project evaluation and/or design. Owner will perform it for every project to confirm there is adequate air capacity to support the future or existing project program. This is required even if there is no anticipated increased load on the air handling system to confirm the system still has adequate capacity to support existing programs. Consultant shall inform PM of any specific information that needs to be captured for their use.

- C. At the completion of the installation work, the Contractor shall execute tests and make adjustments to qualify and quantify that all mechanical systems and subsystems installed or modified under this project function to their respective specified performance and the intent of the Project Documents. All systems shall be operated and tested systematically for capacity, calibration, pressure balances between spaces, balancing and sequence as close to design conditions as possible with maximum attainable internal load. Adjustment to system components shall be made including replacing motor drives, if necessary, to achieve specified performance.
- D. Work shall be conducted under the supervision of an individual certified by NEBB or AABC and trained technicians. All test results shall be documented per the previously approved procedure and transmitted to the Architect/Engineer for review as a requisite for final acceptance and payment. Final inspection shall follow completion and acceptance of the test results.
- E. The balancing contractor shall review plans and specifications for balancing dampers, balancing valves, gauge connections, airflow/pitot sections. The Contractor shall notify the Engineer if the Contractor cannot perform the Work because of inadequate provisions so that the inadequacy can be corrected by change order during project construction without any cost over and above the device itself. No excuses during the testing and balancing procedure will be accepted for Contractor's lack of performance, and the Contractor shall be responsible for the additional cost of adding the required device(s) into the completed systems.
- E. Employment of a Balancing Subcontractor by the Contractor shall not relieve him of obligations to perform Work in accordance with the Project Documents.

#### 20 10 82 REFERENCES

- A. National Standards for Total System Balance, by the Associated Air Balance Council (AABC), latest edition.
- B. Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems, by the National Environmental Balancing Bureau (NEBB), latest edition.
- C. 2019 Application Handbook, Chapter 39, Testing, Adjusting and Balancing by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

#### 20 10 83 WORK INCLUDED

- A. Testing and adjusting each air handling unit and return/relief fan to achieve the design airflow rates as scheduled.
- B. Testing and adjusting each VAV box to achieve design minimum and maximum airflows, water flows, and heating capacity as scheduled.
- C. Testing and adjusting each pump to achieve design water flow rate as scheduled.
- D. Testing and adjusting each coil to achieve design flow rate and capacity as scheduled.
- E. Testing and adjusting each heat exchanger (building heating and pool heating) to achieve design water flow as scheduled.
- F. Testing and adjusting each exhaust fan to achieve design airflow rate as scheduled.
- G. Testing and adjusting the systems to maintain pressure relationships as follows: the Locker Room "negative" with respect to the adjacent spaces and "positive" with respect to the pool; the Natatorium "negative" with respect to all adjacent spaces; the building "positive" with respect to

outdoors. Note this will require repeated balancing of all system to obtain the pressure relationships.

- H. Testing of the PAU-1, 2 & 3 existing systems prior to modification. Also, confirming the current pressure balance of the natatoriums and the current pressure balance of the building.
- I. Furnishing and/or installing fixed sheaves for all fans.
- J. Provide sufficient labor and resources required to assist in the commissioning process, refer to commissioning specification section.

#### 20 10 84 SUBMITTALS

- A. The Contractor shall submit to the Architect/Engineer for approval the following within thirty (30) days of his notice to proceed:
  - 1. Name and address of the proposed Balancing Contractor and their credentials.
  - 2. Name of the Mechanical Contractor's representative responsible for the balancing work.
  - 3. The Contractor shall certify that each system is installed in accordance with the Project Documents, is operable and is prepared for testing and balancing; and that products and systems meet or exceed specified requirements.
- B. The Contractor shall submit the following prior to commencing any testing, adjusting and balancing work:
  - 1. Name of Balancing Contractor's representative for coordination with the Mechanical Contractor.
  - 2. The Contractor shall certify that: all instruments, measuring devices, meters, etc. to be used for his Work have been calibrated to NIST standards including Mechanical Contractor provided permanently installed and portable devices; that supervisor is certified by a recognized national organization; and that personnel are qualified technicians.
  - 3. At least 60 days prior to the beginning of testing the work, the Contractor shall submit to the Architect/Engineer for approval:
    - a. Written proposed procedures of testing, adjusting, balancing and documentation including techniques, methods and responsibilities.
    - b. List of each instrument to be used and latest date and method of calibration to verify accuracy. If more than one (1) year old or accuracy is in question, instrument shall be recalibrated.
    - c. Sample forms for all pieces of equipment to be tested.

#### 20 10 85 RESPONSIBILITIES AND COORDINATION

- A. Work by Contractor, which installed the respective system to be tested, shall include the following:
  - 1. Schedule, coordinate and sequence the testing, adjusting and balancing of the respective systems. Prepare and distribute a schedule. This shall still apply even when the owner is performing the TAB work. Where the owner is performing the TAB work, the Owner's Representative shall be notified at least fourteen (14) days prior to the schedule date for balancing the system. Additionally, a two (2) week allowance for the testing and balancing shall be incorporated into the schedule.
  - 2. Verify that the respective equipment, ductwork, piping and temperature control systems have been provided, each is operable and apparently functioning all in accordance with and

to the intent of the Project Documents. In particular, the following shall be checked and noted as having been accomplished prior to the testing, adjusting and balancing:

- Initial checkout and start-up of all equipment.
  - Pressure and leak testing, and cleaning of all systems.
  - Tagging of all equipment.
  - Alignment and adjustment of motor drives, and lubrication of bearings.
  - **Furnishing and installing fixed sheaves for all fans. If TAB is owner-provided, this shall be done by the Contractor.**
  - Check fan belt tension and fan rotation
  - Start up and proving of all equipment
  - Change air filters
  - All dampers, manual line valves, control valves, and balancing valves shall be operational and in the "open" position. All systems shall have operated successfully for a minimum of 24 hours prior to testing and balancing.
3. Verify that all instruments, measuring devices, meters, immersion wells, taps, valves, specialties, dampers, measuring and sensing elements, access openings, etc. have been provided in correct quantities and locations to permit commencement of the testing, adjusting and balancing of the Work. Correct deficiencies and/or modify the Work, as required.
  4. Provide the Balancing Contractor with all pertinent shop drawings on equipment to be tested, adjusted and balanced.
  5. Provide the Balancing Contractor with a set of "as-built" drawings or the Mechanical Contractor's marked-up "record" set showing all changes to the mechanical systems.
  6. Attend a coordination meeting prior to the balancing of the system and a coordination meeting following the balancing of the system.
  7. Dedicate the resources to accommodate all changes identified by the test and balance firm in a timely manner.
  8. If a significant rebalance (Owner's determination) of the HVAC system is required due to the Contractor's failure to properly install and check out the HVAC system, the cost of rebalancing the system shall be borne by the Contractor.
- B. Work by Balancing Contractor shall include the following:
1. Perform a total system balance in accordance with NEBB or AABC National Standards for Field Measurement and Instrumentation, Total System Balance.
  2. Direct measurement of temperatures, pressures, air and fluid quantitative flow rates and any other values necessary to establish the status of each system in comparison with the Project Documents.
  3. Adjust components and devices to achieve design operating conditions within acceptable tolerances for each system. Do not use shut-off devices for balancing unless indexed. Lock memory stops or mark set points of balancing devices. Replace all system components removed temporarily during the testing and balancing effort, set all

- temperature controls properly and generally leave the systems in working order and “as-new” condition.
4. Report to the Architect/Engineer any existing installed or operating condition that deviates from the design or intent of the Project Documents, and that the Balancing Subcontractor believes to be beyond the scope of his work.
- C. Where TAB is owner-provided, the following shall be completed by the Contractor. Where TAB is Contractor-provided, the following shall be completed by the Balancing Contractor.
1. Furnish fixed sheaves to the Owner, upon acceptance of the balancing report, for fans furnished with adjustable sheaves where the balancing contractor was able to make the required speed adjustments with the factory sheave.
  2. Furnish and install fixed sheaves for fans furnished with adjustable sheaves where a speed change, beyond that obtainable with the adjustable sheave, is required to obtain design airflow. The system shall be proportionally balanced, then the required fan speed shall be calculated based upon the fan laws. Contractor shall also calculate the required brake horsepower at the design airflow, if this exceeds the nameplate horsepower the Architect/Engineer shall be notified.
  3. Furnish and install fixed sheaves for fans furnished with fixed sheaves where a speed change is required to obtain design airflow. The system shall be proportionally balanced, then the required fan speed shall be calculated based upon the fan laws. Contractor shall also calculate the required brake horsepower at the design airflow, if this exceeds the nameplate horsepower the Architect/Engineer shall be notified.

#### 20 10 86 REPORTS

- A. Reports shall be submitted in 9” x 12” binder complete with cover identification, index page, and indexing tabs. Reports shall not contain footnotes explaining why the system was not balanced to the required performance.
- B. The form of the testing and the report shall be submitted and approved prior to testing work. Reports shall be submitted on pre-approved forms.
- C. Diagrams, as required, to clarify locations of measurements and/or reading shall be included in the report.
- D. Final acceptance and payment of the contract shall not be issued before final report is approved.
- E. Air handling unit forms shall contain the following minimum information:
  - Unit Name.
  - Make/Model.
  - Type/Size.
  - Serial Number.
  - Fan Arrangement/Class/Rotation
  - Discharge Location.
  - Sheave Make and No.
  - Sheave Diameter and Bore.
  - No. Belts/Make/Size.
  - Motor Make/Frame.
  - Motor Horsepower.
  - Motor Volts/Phase/Amps.
  - Motor Full Load Amps/S.F.
  - Motor Sheave Make and No.
  - Motor Sheave Diameter and Bore.
  - Sheave Centerline Distance.



Design and Actual Supply CFM.  
Design and Actual Total S.P.  
Design and Actual Fan RPM.  
Design and Actual Motor Volts (each phase).  
Design and Actual Motor Amps (each phase).  
Design and Actual Discharge S.P.  
Design and Actual Suction S.P.  
Design and Actual Pressure Drops Across Components.  
Design and Actual Minimum Outside Air CFM.  
Design and Actual Return Air CFM.  
Coil Condition Wet/Dry.  
Filter Condition Clean/Dirty.  
Minimum Outside Air Damper Position (degrees 90° open; 0° closed)  
Maximum Outside Air Damper Position (degrees 90° open; 0° closed)  
Return Air Damper Position (degrees 90° open; 0° closed) for Positive Pressure on  
Upstream Side and Negative Pressure on Downstream Side

F. Pump forms shall contain the following minimum information:

Pump No.  
Service.  
Make/Model.  
Type/Size.  
Serial Number.  
Seal Type.  
Design Impeller Size.  
Required NPSH.  
Motor Manufacturer/Frame Size.  
Motor HP/RPM.  
Volts/Phase/Amps.  
Full Load Amps.S.F.  
System Pressure (Pump off).  
Shut-off Pressure.  
Actual Impeller Size.  
Design, Preliminary, and Final Flow.  
Design, Preliminary, and Suction, Discharge, and Differential Pressure.  
Design, Preliminary, and Voltage, each phase.  
Design, Preliminary, and Amps, each phase.

G. Air handling unit coil forms shall contain the following minimum information:

System No.  
Location.  
Service (Preheat, Cooling, Reheat).  
Coil Type.  
No. Rows/Fins per inch.  
Manufacturer.  
Model No.  
Face Area (Sq. Ft.).  
Design and Actual Air Quantity.  
Design and Actual Air Velocity.  
Design and Actual Air Pressure Drop (in. w.c.).  
Design and Actual Outside Air DB/WB.  
Design and Actual Return Air DB/WB.  
Design and Actual Entering Air DB/WB.  
Design and Actual Leaving Air DB/WB.

Design and Actual Air  $\Delta T$ .  
Design and Actual Water Flow.  
Design and Actual Water Pressure Drop (ft.).  
Design and Actual Entering Water Temperature.  
Design and Actual Leaving Water Temperature.  
Design and Actual Water  $\Delta T$ .  
Design and Actual Inlet Steam Pressure.  
Design and Actual Control Valve Pressure Drop.  
Design and Actual Expansion Valve.  
Design and Actual Refrigerant Suction Pressure.  
Design and Actual Refrigerant Suction Temperature.

H. Exhaust, return/relief fan forms shall contain the following minimum information:

Unit Name.  
Make/Model.  
Type/Size.  
Serial Number.  
Fan Arrangement/Class/Rotation  
Discharge Location.  
Sheave Make and No.  
Sheave Diameter and Bore.  
No. Belts/Make/Size.  
Motor Make/Frame.  
Motor Horsepower.  
Motor Volts/Phase/Amps.  
Motor Full Load Amps/S.F.  
Motor Sheave Make and No.  
Motor Sheave Diameter and Bore.  
Sheave Centerline Distance.  
Design and Actual CFM.  
Design and Actual Total S.P.  
Design and Actual Fan RPM.  
Design and Actual Motor Volts (each phase).  
Design and Actual Motor Amps (each phase).  
Design and Actual Discharge S.P.  
Design and Actual Suction S.P.

I. Heat Exchanger forms shall contain the following minimum information:

Unit Name.  
Service.  
Rating (Btu/hr).  
Circuiting.  
Manufacturer.  
Model Number.  
Serial Number.  
Design and Actual Steam Pressure.  
Design and Actual Flow Rate (#/hr).  
Primary Water Design and Actual Entering/Leaving Temperature.  
Primary Water Design and Actual  $\Delta T$ .  
Primary Water Design and Actual Air Entering/Leaving Pressure.  
Primary Water Design and Actual Water  $\Delta P$ .  
Primary Water Design and Actual Flow Rate (gpm).

## 20 10 87 PROCEDURES

- A. The procedures listed herein are presented to enhance the procedures of the referenced agencies and the lack of a procedure being presented herein does not relieve the Contractor from following the procedures of the referenced agencies.
- B. In general, balancing dampers shall not be used to adjust the cfm quantity of fans but rather only to adjust the proportion of the airflow within the system. The fan speed shall be adjusted, with all of the dampers open, to a cfm slightly greater than design cfm. Then the dampers shall be adjusted to move more air towards the end of the system. The balancing damper at the furthest points of the system should be nearly full open. If these furthest dampers are not open then the fan speed shall be reduced and the process repeated until a satisfactory result is achieved.
- C. Systems with diversity shall be tested in accordance to a method agreed upon by Engineer and is to be established when the Contractor submits his procedures to the Engineer for approval. Typically this may be: to force the East zones to operate design capacity while west zones are left to operate at their given load; or that some air handling units would be forced to operate at design capacity while other units may be off or left to operate at their given load.
- D. Systems with air economizer cycles shall be adjusted to provide near linear flow as the amount of outdoor varies. Three (3) conditions to be tested are minimum outdoor air, 50% outdoor air, and 100% outdoor air. Record the values of total supply, return, relief, and building differential pressure at each of these conditions. Systems with return fans shall have the return damper adjusted to provide a change from positive to negative gauge pressure to provide a negative mixed air plenum pressure.
- E. When the Contractor has any questions regarding how the systems operate or cannot obtain design performance, they should contact the Engineer for clarifications or further instruction. The work shall not be considered complete until all systems and components achieve design performance unless the Engineer issues written direction otherwise.
- E. All systems shall be adjusted between 10% above the design value as a maximum, to the design value as a minimum.

## **20 10 90 BASIC MECHANICAL METHODS - IDENTIFICATION**

### 20 10 91 GENERAL

- A. This Sub-section specifies basic materials and methods for identification that shall apply to systems specified in other sections of Divisions 20 - 29 of the Specifications.
- B. The Contractor shall submit schedules and listings of Work to be identified indicating color code, material, name plate information and method of application for approval prior to performing the Work.

### 20 10 92 REFERENCES

- A. All provisions and conditions cited in this Sub-section shall apply to Work of all other sections of Divisions 20 - 29 of these Specifications, where and when relevant.
- B. Applicable requirements of the current and accepted edition of the following codes and standards shall apply to the Work of this Sub-section:

1. ANSI/ASME A 13.1 - "Scheme for the Identification of Piping Systems".

20 10 93 WORK INCLUDED

- A. Each respective Contractor and Subcontractor shall identify the applicable components of his Work in accordance with specifications hereinafter enumerated or where required by other sections of Divisions 20 - 29 of the Specifications.
1. All equipment items (i.e., air handling units, fans, pumps, etc.).
  2. All chilled water, heating water, steam and condensate, plumbing, and fire protection valves both new and existing.
  3. All piping systems identifying the system type and direction of flow.
  4. All control devices and panels.

20 10 94 SUBMITTALS

- A. Contractor shall submit shop drawings for approval in accordance with Section 20 00 43 submittals.
- B. Provide an Identification Product Schedule consisting of the following minimum information:
- Material - type of identification product.
  - System - indicate which system or equipment materials will be used for.
  - Manufacturer - Manufacturer's name, product name and model numbers.
  - Accessories - Miscellaneous materials used in affixing identification.
- C. Provide manufacturer's technical product sheet and recommended installation instructions.
- D. Provide color list/schedule and lettering sizes for pipe markers, valve tags, and equipment nameplates.
- E. Provide a valve tag list for approval prior to ordering or making valve tags.

20 10 95 GENERAL METHODS FOR IDENTIFICATION

- A. All surfaces to receive identification nameplates or markers shall be clean, degreased, dry, free of oxidation and prepared per manufacturer's recommendations.
- B. Plastic nameplates shall be installed with corrosion-resistant mechanical fasteners. Do not use adhesives.
- C. Tags shall be installed with corrosion-resistant chain and end fasteners.
- D. Pipe and duct markers shall be installed in accordance with the manufacturer's recommendations.
- E. Valve tag list for each separate trade i.e., mechanical, plumbing, fire protection, and temperature control shall each provide a valve tag list in electronic format or under glass in a suitable frame located in a location approved by Architect/Engineer.
- E. Valve tag information is required on "as-built" drawing submittals.
- G. Acceptable Manufacturers:  
Products of the following manufacturers may be considered
1. Seton Nameplate Corp.

2. Brady Signmark Division
3. Craftmark Identification Systems
4. D & G Sign and Label

20 10 96 PIPING IDENTIFICATION

- A. All piping, bare pipe or insulated, exposed or concealed, shall be identified by one of the methods specified herein.
- B. Markers shall be installed in clear view; aligned with axis of pipe; located at not more than twenty-five foot (25') intervals on straight runs, risers and drops; located adjacent to each valve, control device and tee fitting; and located on each side of penetrations of the building structure and non-accessible enclosures.
- C. The following schedule shall govern label types for each application:

<u>Location</u>	<u>Type</u>
Mechanical Rooms	II
Above Lay-in Ceilings	I
Exterior/Outdoors	III

1. Pressure Sensitive Tape (Type I): Vinyl pressure sensitive tape color coded and lettered in accordance with ANSI A13.1 for label of service. Flow direction shall be separately labeled with 2" wide pressure sensitive tape. The flow arrow band shall overlap the service label to secure it in place and shall not be less than two complete wraps around the pipe.
2. Plastic Pipe Markers (Type II): Manufactured in accordance with ANSI A13.1 requirements, semi-rigid plastic, pre-formed to fit curvature of pipe or pipe insulation, color coded and imprinted with media identification and flow direction. Available in varied sizes for pipe diameter, wording and inclusion of arrow.
3. Outdoor Pipe Markers (Type III): Non-vinyl chloride markers specifically design for outdoor use. Color coded and lettered in accordance with ANSI A13.1 for label of service with direction of flow arrows.

<u>Outside diameter of bare pipe or insulated pipe</u>	<u>Size of letters</u>	<u>Length of color field</u>
3/4" - 1-1/4"	1/2"	8"
1-1/2" - 2"	3/4"	8"
2-1/2" - 6"	1-1/4"	12"
8" - 10"	2-1/2"	24"
10" and larger	3-1/2"	32"

- D. The following legend, color, and lettering shall be used:

<u>Service</u>	<u>Color of Field</u>	<u>Letters</u>
Hot Water Supply	Green	White
Hot Water Return	Green	White
Low Pressure Steam	Green	White
Low Pressure Steam Condensate	Green	White
Pumped Condensate	Green	White
Waste	Green	White
Vent	Green	White
Chilled Water Supply	Green	White
Chilled Water Return	Green	White
Drain	Green	White
Roof Drain	Green	White

Fire Quenching Materials:  
Sprinkler – Fire

Red

White

20 10 97 VALVE IDENTIFICATION

- A. All valves exposed or concealed shall be identified with brass valve tags indicating the service of system the valve is in and the number of the valve.
- B. Valve tags shall be minimum 1-1/2" diameter brass stock with 1/4" legend identifying and 1/2" valve number both shall be black enamel filled. Legends shall be HVAC, PLBG, SPR, and GAS.
- C. Valve tags shall be secured in place with a No. 6 brass bead chain or No. 16 brass jack chain. Chains shall be attached to the valve lever handle or around the valve stem.
- D. An additional 10 consecutively numbered tags for each service shall be provided to the Owner for future use.
- E. The existing systems are identified and a list can be obtained from the Owner. Additions to the existing systems shall start numbering at a multiple of (10) plus (1) leaving a minimum of 10 valve numbers between the existing system and the new (i.e., if the existing numbering stops at 66, the new number shall be at 81). The existing numbering convention shall be followed as closely as possible.
- F. Balance valves that are not used as a combination balance/service valve are not required to be labeled.
- G. Temperature control valves shall be identified with a 1/4" "T.C." legend and shall be numbered consecutively starting with major equipment and then terminal units (i.e., AHU-1 preheat, cooling, reheat control valves shall be numbered 1, 2, 3 respectively).

20 10 98 EQUIPMENT IDENTIFICATION

- A. All major equipment items (i.e., chillers, air handling units, fans, terminal units, pumps, boilers, etc.) shall be identified with appropriately sized nameplates permanently attached to the respective equipment.
- B. Small equipment items (i.e., in-line pumps, pot feeders, etc.) shall be identified with brass valve tags, see requirements for valve tags and chains.
- C. Equipment that is controlled by the Building Automation Control System shall be labeled with a 2" x 5" yellow label with black letters:  
"CAUTION – THIS EQUIPMENT IS UNDER COMPUTER CONTROL AND MAY CYCLE AT ANY TIME."
- D. Interior equipment nameplates shall be 1/16" thick two-ply acrylic plastic 2-1/2" x 1" size minimum with white letters on a black background. Tag size shall be appropriate for equipment name, letters shall be a minimum of 1/2" high.
- E. Exterior equipment shall be identified with nameplates suitable for exterior use or shall be engraved aluminum plates .020" thick, minimum size shall be 4" x 1-1/2" plates.
- F. Nameplates shall be attached with corrosion-resistant No. 3 round head or No. 4 sheetmetal screws.

## 20 10 99 DUCTWORK IDENTIFICATION

- A. Supply, return and exhaust ductwork uninsulated or insulated, exposed or concealed, shall be identified as specified herein, except for exposed ductwork in finished areas.
- B. Markers shall be installed in clear view; installed on both sides of the duct; run parallel to the ductwork; located at not more than twenty-five foot (25') intervals on straight runs at all branch locations; and located on each side of penetrations of the building structure and non-accessible enclosures.
- C. Markers shall be pressure sensitive vinyl tape labeled for service and direction of airflow. Minimum size shall be 2" high x 8" long.
- D. Supply, return, exhaust and outdoor air ductwork labels shall be blue with white letters. Hazardous exhaust air ductwork labels shall be yellow. Outdoor air labels shall have an "air" legend.

## 20 10 100 CONTROL DEVICES IDENTIFICATION

- A. The materials specified herein Section 20 10 90 shall apply to Division 25 Temperature Control Systems. Additional identification work is specified in Division 25.

## **20 20 10 ELECTRICAL REQUIREMENTS**

### 20 20 11 GENERAL

- A. This Subsection specifies the basic requirements for electrical components which are an integral part of "packaged" mechanical equipment. These components include, but are not limited to, factory installed motors, starters, disconnect switches, control panels and related prewiring of power and control wiring for a single external electrical service connection. All material and equipment shall be provided for the application and service intended.
- B. Specific electrical requirements (e.g. horsepower, electric characteristics, etc.) for mechanical equipment shall be specified within the respective equipment specifications or shall be scheduled on the Plans.
- C. The Contractor shall verify that electrical characteristics of material and equipment furnished for Divisions 20 - 25 equipment are in accordance with the electric service and comply with the specifications and requirements of Division 26 - 29.
- D. Unless otherwise specified as an integral part of packaged mechanical equipment, motor control centers, motor starters and disconnect switches and the power wiring from power source to motor starting equipment (including variable frequency drive packages) and wiring from that equipment to the respective motors including final connections shall be performed as Electrical Work of Division 26 - 29.
- E. The field installation of electrical components, not included in Division 26 - 29, that are specified to be provided with the mechanical equipment and are shipped separately shall be the responsibility of the Contractor furnishing the base equipment.
- F. All electrical components and material shall be UL labeled.
- G. Submittals for the applicable electrical equipment shall include the following: identification of the equipment which the electrical material is to serve, application, voltage, phases, full load

amperage, wattage and NEMA enclosure. For motors: horsepower, RPM, full load power factor and efficiency, frame size and service factor.

- H. Identification of electrical components of mechanical equipment shall be in accordance with Subsection 20 10 90, "Basic Mechanical Methods - Identification".

## 20 20 12 REFERENCES

- A. Electrical material and equipment provided for Divisions 20 - 29 shall meet the applicable requirements of the latest accepted edition of the following codes and standards:

ANSI	American National Standards Institute
EI	Edison Electrical Institute
IEEE	Institute of Electrical and Electronic Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriter's Laboratories, Inc.

## 20 20 13 MOTORS

- A. The following are basic minimum requirements for all motors. Additional motors, more detailed and specific requirements may be specified with the respective equipment.
- B. Single-phase motors shall be provided for all motors 1/2 HP or less, except as specified or scheduled otherwise and shall be of the permanent split capacitor (PSC) type.
- C. Polyphase motors shall be provided for all motors 3/4 HP or larger, except as specified or scheduled otherwise with a minimum power factor of .85 at 65% of full load or shall be power factor corrected.
- D. Multi-speed motors shall have dual windings wound to the speeds scheduled or specified.
- E. Torque characteristics shall be sufficient to satisfactorily accelerate the driven load(s) with low in rush current.
- E. Motor horsepower sizes shall be large enough so that the driven load shall not require the motor to operate in the service factor range.
- G. Temperature rating: Rated for 40 deg. C environment with maximum temperature rise for continuous duty at full load of 40°C for open dripproof motors, 50°C for splash proof motors, and 55°C for totally enclosed motors (Class B insulation). Motors used with variable frequency drives/inverters shall be NEMA MG1, Part 31 Compliant and have a Class B temperature rise with Class F insulation design to resist transient spikes, high frequencies, and short rise time pulses produced by inverters.
- H. Starting capability: Frequency of starts as specified by the automatic control system. For manually controlled motors, not less than five (5) evenly time spaced starts per hour.
- I. Service factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- J. Motor construction:
  1. NEMA standard frame sizes, general-purpose open dripproof (unless otherwise specified), continuous duty, Design "B" (unless "C" is required for high starting torque). Motor frame, end bells and conduit box shall be cast iron; stator windings shall be copper. Aluminum is unacceptable for any parts. Provide grounding lug in motor terminal box.



2. Motors located outdoors or otherwise exposed to water, dust, etc where an open motor would not be suited, shall be totally enclosed fan-cooled (TEFC).
  3. Bearings: Ball or roller bearings with inner and outer shaft seals. Externally accessible inlet/outlet grease fittings. Where motors are enclosed within equipment, extend grease tubing to exterior of the enclosure. Bearings designed to resist thrust loading for drives producing lateral or axial thrust. Fractional horsepower, light duty motors may have sleeve bearings.
  4. Overload protection: Built-in thermal overload protection.
  5. Noise rating: Motors shall meet IEEE, Standard 85.
  6. Efficiency: Motors shall be NEMA Premium Efficiency per NEMA Standards Publication MG 1-2003, Table 12-12 and 12-13.
  7. Nameplate: Indicate full identification of manufacturer's name, model number, serial number, horsepower, speed, voltage, characteristics, construction, special features, etc. Nameplates in harsh environments such as for cooling towers, or in pool equipment rooms, etc. shall be suited to the specific application.
- K. Acceptable manufacturers: Baldor, General Electric, Gould, Marathon, Magnetek, Reliance, Siemens, Toshiba, and U.S. motors.

#### 20 20 14 MOTOR CONTROLS

- A. Motor Starters: NEMA 1, general-purpose enclosures with padlock ears, unless specified otherwise. Type, size and duty shall be as specified or as recommended by the motor manufacturer and the requirements of the driven equipment for applicable protection and start-up conditions.
- B. Manual Starters: Pilot light and extra positions for multi-speed motors. Melting alloy type thermal overload relay protection.
- C. Magnetic Starters: Hand-off-Auto selector switches, pilot lights, interlock contacts, switches and other devices as required for control requirements. Trip-free thermal overload relays for each phase. Built-in 120 volt control circuit transformer, fused from line side, where power service exceeds 240 volts. Externally operated manual reset; under-voltage release of protection.
- D. Acceptable Manufacturers: Allen-Bradley, Cutler-Hammer, General Electric, Square D.

#### 20 20 15 DISCONNECT SWITCHES

- A. Fusible: For 3/4 horsepower and larger. Disconnect switch shall be horsepower rated, heavy duty, spring reinforced fuse clips each phase, quick-make/quick-break mechanism with arc quenchers, dead front line side shield, solderless lugs, silver electroplated current carrying parts, lockable hinged door, capacity and electric characteristics as specified.
- B. Non-fusible: For 1/2 horsepower motor and smaller. Disconnect switch shall be horsepower rated, toggle switch type, quantity of poles and voltage rating as specified.

#### 20 20 16 MULTI-SPEED MOTORS AND CONTROLS

- A. Multi-speed motors, when required, shall be specified under the heading of the respective equipment to be driven.
- B. Motor controls for multi-speed applications shall be specified, also, under the heading of the respective equipment, if said equipment is a "packaged" type unit.
- C. Otherwise, multi-speed motor controls shall be specified in Division 26.

#### 20 20 17 VARIABLE SPEED DRIVES

- A. Motor controls for variable speed drives shall be specified under the heading of the respective equipment, if said equipment is a “packaged” type unit.
- B. Otherwise, variable speed drives shall be specified in Division 26.

#### 20 20 18 CONTROL PANEL

- A. NEMA 1 general-purpose enclosure for indoor application; NEMA 3R weather resistant enclosure for exterior location.
- B. Factory mount panel(s) and internal power and control devices. Pre-wire all devices for the operation of the related equipment so that only one main power connection shall be required in the field.
- C. Provide internal protection for each circuit, maximum 120-volt secondary control transformer(s), terminal strips for wiring terminations, identification of components and wiring diagram inside the cover.

#### **20 20 20 DRIVES AND GUARDS**

##### 20 20 21 GENERAL

- A. This Subsection covers V-belt, sprocket-chain, gear and direct coupled drives.
- B. All drives shall be selected for 150% of specified motor nameplate horsepower.
- C. All drives shall be installed, balanced and aligned in accordance with the respective manufacturer's instructions and recommendations.

##### 20 20 22 V-BELT DRIVES

- A. All motors shall be provided with variable pitch pulleys with design RPM at mid-range of adjustment.
- B. V-belts shall be premium quality, endless cord impregnated rubber with trapezoidal cross section, type A, B, C or D, matched set (if more than one), 95% minimum drive efficiency.
- C. The driving motor shall be installed on an adjustable bolt device to provide for belt tension adjustment.
- D. Acceptable manufacturers:
  - 1. V-belt drives: Browning, Eaton, Gates

##### 20 20 23 DIRECT DRIVES

- A. Wherever available, motors and related direct driven equipment shall be mounted on a common base.

20 20 24 GUARDS

- A. All belts, chains, pulleys, shafts, sheaves, sprockets, gears, couplings, projecting setscrews, keys and any other rotating parts shall be provided with guards by the Contractor furnishing the base equipment.
- B. Guards shall be designed and arranged in accordance with OSHA requirements.
- C. Guards shall completely enclose the drive, shall be secured to the respective equipment and shall be removable for servicing. Wherever available from the manufacturer, guards shall be provided with the equipment. If not, these shall be field fabricated.
- D. Provide reinforced openings with removable coverplates for access to motor and driven shafts for speed measurement.
- E. Extend tubing for grease fittings inside the guard to accessible locations outside the guard.

20 20 25 INSTALLATION AND OPERATION

- A. Install, balance and align all drives in accordance with the respective manufacturer's instructions and recommendations.
- B. The balancing and alignment of drives including pinning, doweling and grouting shall be the responsibility of the Contractor furnishing the equipment. Any adversities arising from executing the Work shall be resolved/remedied by the Contractor.
- C. Verify all electrical characteristics prior to running electric motor driven equipment. Check motor amperage draw and rotation for proper operation.

END OF SECTION

## **20 25 00 INSULATION**

### 20 25 01 GENERAL

- A. This Section specifies mechanical insulation of piping, equipment and ductwork.
- B. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Divisions 20 - 29 of the Specifications.
- C. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 20 - 29 of these Specifications.

### 20 25 02 REFERENCES, REGULATORY REQUIREMENTS

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20 in addition to the following:
  - 1. State and local Air Pollution Codes and Regulations.
  - 2. NFPA 255/UL 723/ASTM E-84 Surface Burning Characteristics of Building Materials.
  - 3. UL 1479/ASTM E-814 Fire Test of Through-Penetration Firestops.

### 20 25 03 RELATED SECTIONS OF THE SPECIFICATIONS

- A. Requirements of the following Sections of the Specifications apply to Work for this Section:
  - .1 Division 20 - Basic Mechanical Conditions
  - .2 Division 20 - Basic Mechanical Materials and Methods
  - .3 Division 22 - Plumbing Work
  - .4 Division 23 - HVAC Piping and Equipment
  - .5 Division 24 - Air Distribution

### 20 25 04 DEFINITIONS

- A. The term **“fitting”** where used in this Section of the Specifications shall be construed as an elbow, tee or reducer. Unions, flanges and valves shall not be considered as fittings.
- B. The term **“cold”** shall be defined as the temperature of a surface that may result in the formation of condensation.
- C. The term **“accessory”** shall include staples, bands, wire, mesh, clips, pins, studs, tape, anchors, corner angles, cements, adhesives, coatings, sealers, mastics, finishes, etc.
- D. The term **“ASJ”** where used in this Section of the Specifications shall mean a reinforced vapor retarding All Service Jacket.
- E. The term **“SSL”** where used in this Section of the Specifications shall mean Self-sealing Lap Joint closure system for longitudinal jacket joints.
- E. The term **“supply air”** where used in this Section of the Specifications shall mean downstream of a coil.
- G. The term **“outdoor air”** where used in this Section of the Specifications shall mean ambient air that has not been conditioned.
- H. The term **“return air”** where used in this Section of the Specifications shall mean conditioned air that is returned from the space.

- I. The term “**mixed air**” where used in this Section of the Specifications shall mean air streams that are a mixture of “outdoor air” and “return air”.
- J. The term “**relief air**” where used in this Section of the Specifications shall mean excess return air that is relieved from the building.
- K. The term “**exhaust air**” where used in this Section of the Specifications shall mean air that is removed due to contaminates, odors, or heat.

20 25 05 WORK INCLUDED

- A. Furnish material, labor and services necessary for and incidental to the insulation of the following systems where shown on the Plans and as hereinafter specified. Include all necessary considerations in the related sections of the Specifications (Subsection 20 25 03) to perform the Work completely.
  - 1. Chilled water piping.
  - 2. Heating water piping.
  - 3. Condensate drain piping.
  - 4. Waste piping and floor drains located above grade serving condensate drains.
  - 5. Make-up cold water piping.
  - 6. Low pressure (15# and less) steam supply piping.
  - 7. LP steam condensate return and condensate pump discharge.
  - 8. Pumps, equipment and specialties.
  - 9. Heat exchangers and other heating equipment.
  - 10. Ductwork/sheetmetal systems.
  - 11. Storm water drainage.
  - 12. Heat traced piping (above grade).
- B. Providing appropriate size calcium silicate/cellular glass/pipe shield manufactured inserts to the trade contractor for installation between the pipes and oversized hangers as specified in this section.
- C. Fire wrapping piping system located in occupied spaces or plenum spaces that do not meet flame spread 25 and smoke development 50.

20 25 06 SUBMITTALS

- A. The Contractor shall submit shop drawings for approval in accordance with Subsection 20 00 43, Duties of Contractor - Submittals.
- B. Provide an INSULATION PRODUCT SCHEDULE consisting of the following minimum information:
  - Material - type of insulation material, jackets, or covers.
  - Manufacturer - manufacturers name, product name, and K-value where applicable.
  - Accessories - tapes, staples, coatings, adhesives including manufacturer's name and product name.
  - Systems - indicate systems where product is used.
- C. Provide an INSULATION THICKNESS SCHEDULE consisting of the following minimum information:

System - indicate which system insulation is installed.  
Location - inside, outside, concealed, exposed, etc.  
Size - indicate size range of pipe, insulation type used.  
Thickness - indicate insulation thickness in inches.

- D. Provide manufacturer's technical product data of each material and accessory item with engineering support information and recommended installation procedure. Indicate product number, "K" value, thickness and required accessories for each application.
- E. At the completion of the project, submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.

#### 20 25 07 SPECIAL REQUIREMENTS

- A. Contractor's Qualifications: Contracting company shall be one specializing in insulation application and have a minimum of three (3) years experience in this work.

#### **20 25 10 INSULATION MATERIALS**

##### 20 25 11 GENERAL

- A. Materials and accessories furnished for this Section of the Specifications shall be standard cataloged products, new, commercially available and suitable for the service specified.
- B. Insulation material and/or accessories containing asbestos are prohibited.

##### 20 25 12 FIRE SAFETY STANDARDS

- A. All insulation material shall have composite fire and smoke hazard ratings in accordance with NFPA 255 and UL 723 not exceeding the following values as tested by the latest procedures of ASTM E-84: flame spread of 25; smoke developed of 50.
- B. Accessories such as adhesives, mastics, cements, tapes and cloths for seams, joints and fittings shall have the same ratings as hereinbefore listed. All products and their respective shipping cartons shall have indications that flame and smoke ratings meet the aforementioned requirements. Any treatment of jackets or facings to impart acceptable flame and smoke safety values shall be permanent; water-soluble applications are prohibited. The Insulation Contractor shall bear responsibility that all products to be used meet the foregoing criteria.

##### 20 25 13 TYPES OF INSULATION MATERIALS

The following types of insulation material are enumerated in the respective INSULATION MATERIAL SCHEDULE. K values listed are in units of (Btu in/hr ft.2 °F) and are based on specific products and are to be met or exceed. ANSI/ASTM types or class shall not provide relief for any K value specified.

- A. Type CS: Hydrous calcium silicate, molded pipe or block form, asbestos free, ANSI/ASTM C533, Type I, "k" value of 0.41 at 200 degrees F for pipe, "k" value of 0.39 at 200 degrees F for block, density of 15#/cubic foot. Owens-Corning Calcium Silicate or equivalent by Knauf, Manville or Pabco.
- B. Type GF1: Glass fiber, non-combustible, preformed for pipe and tube application, ANSI/ASTM C547, Class 1, "k" value of 0.23 at 75 degrees F. Owens-Corning type ASJ with SSL-II vapor retarder jacket or equivalent by CertainTeed, Knauf, Manville or Schuller.

- C. Type GF2: Glass fiber, non-combustible, rigid board with vapor retarder facing, ANSI/ASTM C612, "k" value of 0.24 at 75 degrees F, density of 3#/cubic foot. Owens-Corning type 703 with ASJ 25 jacket or equivalent by CertainTeed, Knauf, Manville or Schuller.
- D. Type GF3: Glass fiber, flexible blanket, laminated to reinforced kraft vapor retarder facing, ANSI/ASTM C553, Type II, "k" value of 0.27 at 75 degrees F, density of 1#/cubic foot. Owens-Corning type 100 All-Service faced duct wrap or equivalent by CertainTeed, Knauf, Manville or Schuller.
- E. Type F1: Flexible elastomeric foamplastic with smooth exterior surface, preformed for pipe and tube application, ASTM C534, Type I, "k" value of 0.28 at 75 deg. F. Armstrong AP Armaflex pipe insulation, K-Flex LS tube, Aerocel EDPM tube.
- E. Type F2: Flexible elastomeric foamplastic with smooth exterior surface, sheet material, ASTM C534, type II, "k" value of 0.28 at 75 degrees F. Armstrong AP Armaflex sheet material, K-Flex LS sheet, Aerocel EDPM sheet.
- G. Type FG: Rigid foamglass preformed for pipe applications ASTM C552, K value of 0.33 at 75°F with all-purpose vapor retarder jacket. Pittsburgh Corning Foamglass.
- H. Type PI: Polyisocyanurate preformed for pipe applications ASTM C591, aged "k" value of 0.19 at 75 degrees F, density of 2#/cubic foot. Shall be ASTM E84 less than 25/50 rated. Saran 560 vapor barrier.
- I. Type PH: Phenolic preformed for pipe applications ASTM C1126, Type III, grade 1. ASTM E84 less than 25/50 rated, Saran 560 vapor varrier, 0.15@75°F.

#### 20 25 14 TYPES OF PIPING JACKET MATERIALS

- A. .0016" aluminum or 0.010" stainless steel jackets with moisture barrier shall be cut and fitted to size required. Fold a 1/2" safety edge on exposed side, roll to diameter required and secure with 1/2" x 0.020" aluminum or 1/2" x 0.015" stainless steel bands respectively on 9" centers (4 bands per 3 foot section of jacketing). Provide appropriate seals, and shed water toward low end of pitched piping. Install lap on top quadrant (2 or 10 o'clock position) of outside diameter of insulation and line up bands and seals to present neat and workmanlike appearance. Fitting covers shall be consistent with piping insulation jacketing. Secure in place with SS screws or banding. Seal with approved caulking. Sharp edges shall be turned under or otherwise protected.

PVC jacketing 0.030" thick for pipe insulation and PVC fitting covers shall be applied over the insulation and vapor barrier system where indicated below for aesthetics or mild abuse areas.

- B. Finish piping insulation with factory or field application for respective locations as follows:

Dry, low abuse: (indoor)	Concealed, not exposed to view. Mechanical equipment room. Exposed, finish space.
-----------------------------	---

Pipe:	ASJ jacket.
Fittings:	Pre-molded PVC covers.

Outdoors:	All
Pipe:	Smooth aluminum jacket with seam on topside at 2 or 10 o'clock position of horizontal runs.

Fittings:	Formed aluminum covers.
Wet areas: (indoor)	Basement mechanical rooms
Pipe:	PVC cover.
Fittings:	Pre-molded PVC covers.

#### 20 25 15 DELIVERY AND STORAGE OF MATERIALS

- A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- B. The Contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The Contractor shall also use all means necessary to protect work and materials installed by other trades.
- C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the Contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the Contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance and provide the Architect/Engineer with a copy of manufacturer's recommendation for approval.

#### 20 25 16 ACCEPTABLE MANUFACTURERS

The following are acceptable manufacturers for products specified in this section of the specification.

- A. Metal jackets:
  - 1. Childers Products Co., Inc.
  - 2. Insul-Coustics
  - 3. Pabco Surfit Metal Corp.
  - 4. RPR Products, Inc.
- B. PVC covers:
  - 1. Proto Corp.
  - 2. Ceelco Corp.
  - 3. Speedline PVC Corp.
- C. Adhesives and Coatings:
  - 1. Alpha Associates
  - 2. Miracle Adhesives
  - 3. Vimasco Corporation
- D. Fasteners
  - 1. ACS Industries



2. GEMCO
3. Midwest Fasteners

E. Fire Stop

1. 3M
2. Metacaulk
3. Specified Technologies, Inc.
4. USG Interior, Inc.

**20 25 20 INSULATION MATERIAL SCHEDULES: <SEE FOLLOWING PAGES>**

20 25 21 INSULATION MATERIAL SCHEDULE I-1

	<u>Hot and cold piping</u>	<u>Thickness</u>	<u>Insulation material</u>
A.	Chilled water supply and return piping 2" and smaller	3/4"	Type PI*, PH, F1
	2-1/2" through 5"	1"	Type PI*, PH, F1 (Contractor's option)
	6" and larger	1-1/2"	Type PI, PH
B.	Hot water (141°F – 200°F) supply and return 1-1/4" and smaller	1-1/2"	Type GF1, F1
	1-1/2" and larger	2"	(Contractor's option)
C.	Low pressure steam condensate return piping including condensate pump discharge 1-1/4" and smaller	1-1/2"	Type GF1
	1-1/2" and larger	2"	
D.	Low pressure (15# and less) steam supply 3" and smaller	2-1/2"	Type GF1
	4" and larger	3"	
E.	Steam supply (16# to 120#) 3/4" and smaller	3"	Type GF1
	1" and 1-1/4"	4"	
	1-1/2" and larger	4-1/2"	
F.	Electrically heat traced piping, all sizes.	1-1/2"	Type as specified for the system.
G.	Domestic water- hot, hot recirc. 2" and smaller	1"	Type GF1, F1 (Contractor's option)
	2-1/2" and larger	1-1/2"	Type GF1
H.	Domestic water-cold	1/2"	Type F1, GF1 (Contractor's option)
I.	Storm water from the roof drain to the first floor level below the roof. Thereafter, all horizontal piping only and related elbows to vertical. Insulate drain body with 1/2" sheet Armaflex.	1"	Type GF1
J.	Condensate Drain Lines:		
	All inside - except air handling units in Mech Rooms where drain line is 2'-0" or less in total length and located at the Mechanical Room floor.	1/2"	Type F1
	All outside	1/2"	Type F1

20 25 21 INSULATION MATERIAL SCHEDULE I-1 <CONTINUED>

K.	Waste Piping and Floor Drains:	1/2"	Type F1
	Piping above grade serving floor drains, hub drains, indirect cabinets, etc., that receive condensate from cooling coils. Insulate piping to where it connects to main waste pipe.		
L.	Fittings (hot and cold):	Molded/preformed fittings, secured in place with twine or tape, seal all "cold" applications prior to installing jacket material.	
M.	Unions, flanges: Valves: (cold piping)	Type F1, same thickness as adjacent piping. Form external collar, minimum 1" overlap on adjacent insulation. Use adhesive to secure in place and maintain vapor barrier.	
N.	Unions, flanges: (hot piping)	No insulation.	
O.	Valves (hot piping):	Insulate valve body only.	
P.	Joints:	Lines subject to condensation: seal longitudinal laps of jacket with adhesive and wrap butt joints between sections with 2" wide tape.	

20 25 22 INSULATION MATERIAL SCHEDULE I-2

	<u>"Cold" equipment</u>	<u>Thickness</u>
A.	Chilled (cold) surfaces, not factory insulated, interior application	3/4"
B.	Insulation material:	Type F2
C.	Fittings:	Type F1
D.	Unions, flanges: Valves:	Same requirements as "Fittings" or use Type F2.
E.	Joints and seams:	Seal with Armstrong 520 adhesive.
F.	Finish, interior:	No additional finish required.
G.	Finish, exterior:	Seal with (2) coats of WB Armaflex.
H.	Hangers, supports:	Outside insulation with continuous vapor barrier. (This may be difficult to accomplish, particularly if equipment is heavy. If hanger or support is in direct contact with equipment, insulate immediate support and connecting member(s) for length of 12" away.)

20 25 23 INSULATION MATERIAL SCHEDULE I-3

	<u>"Hot" equipment</u>	<u>Thickness</u>
A.	Heat exchangers	2"
B.	Hot water pump impeller housings	2"
C.	Insulation Material:	Type GF2
	Option #1:	Owens-Corning type ASJ w/ SSL jacket for round surfaces
	Option #2:	Owens-Corning Pipe & Tank Insulation for round surfaces
D.	Flanges:	No insulation.
E.	Attachment:	Secure rigid board with welded pins on 12" centers. Secure with 3/4" x 0.020" SS bands on 12" centers. Fit ends of tanks and irregular surfaces by segmenting or scoring board and wiring into place.
F.	Joints:	Point and fill-in all joints and voids with insulating cement or fill-in all joints and voids by stuffing with mineral wool.
G.	Finish:	0.016" smooth aluminum jacket with moisture barrier, secured with 1/2" x 0.015" SS bands on 9" centers and SS sheet metal screws.

20 25 24 INSULATION MATERIAL SCHEDULE I-4

A. Service: Ductwork, 0 to 250 degrees F.

Location

Thickness

B. Unconditioned Spaces and Mechanical Rooms

- |    |  |    |
|----|--|----|
| 1. | Supply Air, Heated or Cooled Make-up/Ventilation Air | 2" |
| 2. | Return Air   | 2" |
| 3. | Outdoor Air  | 2" |
| 4. | Outdoor Air Plenums                                  | 2" |
| 5. | Exhaust / Relief Air                                 | 2" |

C. Conditioned Spaces and Return Air Plenums

- |    |  |     |
|----|--|-----|
| 1. | Supply Air, Heated or Cooled Make-up/Ventilation Air | 1"  |
| 2. | Return Air   | N/A |

D. Outside of the Building Insulation Envelope

- |    |  |    |
|----|--|----|
| 1. | Supply Air, Heated or Cooled Make-up/Ventilation Air | 2" |
| 2. | Outdoor Air  | 2" |
| 3. | Exhaust / Relief Air                                 | 2" |

E. Insulation Material

- |    |                      |          |
|----|----------------------|----------|
| 1. | Rectangular ducts    | Type GF2 |
| 2. | Round and Oval Ducts | Type GF3 |

## **20 25 30 INSULATION APPLICATION**

### 20 25 31 INSULATION APPLICATION - GENERAL

- A. Respective piping system, duct system and/or equipment shall be pressure tested, proved tight and accepted, as specified in section for installation of such, before insulation is applied. Sheet metal ductwork joints shall be sealed prior to insulating. Coordination among the respective contractors is essential.
- B. Insulation materials and accessories shall be applied in accordance with respective manufacturer's recommendations and recognized industry practice for the insulation to serve its intended purpose. All surfaces to receive insulation shall be clean, dry, free of oxidation and prepared as required.
- C. The insulation work shall be subject to inspection during the various applications and construction phases. Material, accessories, finishes, methods and workmanship that are not in compliance with these Specifications and/or approved submittals may lead to rejection of the Work and replacement at the Contractor's expense.
- D. Tie-ins to existing systems and all new work shall be insulated to provide a complete and functional system. Finishes shall be compatible wherever possible.
  - 1. When existing insulation thickness is different than the specified thickness herein, the Contractor shall notify the Architect/Engineer. It is the intent that the existing piping would be restored to its original condition (thickness and finish) as if new work had not been performed.
- E. Where heat tracing is utilized for piping and/or equipment shall be installed, tested and accepted before insulation is applied.
- E. Painting of piping for corrosion protection, where specified, shall be performed before insulation is applied.

### 20 25 32 INSULATION APPLICATION - PIPING

- A. Insulate each piping section with single thickness full-length units of insulation, with a single cut piece to complete the run where a fitting is encountered. Do not use cut pieces or scraps abutting each other.
- B. Extend piping insulation without interruptions through walls, floors, and similar piping penetrations, except where otherwise specified.
- C. Insulation on unions, flanges, valves, strainers, expansion joints, pump impeller housings and other equipment requiring accessible servicing shall be removable and reusable without damage. Items requiring periodic attention shall have covers and/or casings to contain the insulation.
- D. All "cold" piping systems shall be insulated with type and thickness of material herein specified and shall have a continuous vapor retarder through all fittings, hangers, supports and sleeves.
- E. In cold systems flanges, unions, valves, etc., shall be covered with an oversized pipe insulation section sized to provide the same thickness as on the main piping section. An oversized insulation section shall be used to form a collar between two insulation sections with low-density blanket insulation being used to fill gaps. Jacketing shall match that used on main piping system. Rough cut ends shall be coated with suitable weather and/or vapor resistant mastic as

required by the system location and service. All valve stems must be sealed with caulking that allows free movement of the stem but provides a seal against moisture incursion.

- E. In hot system flanges, unions, valves, etc., shall be left exposed; insulation ends shall be tapered and sealed to allow bolts to be removed or other required access.
- G. The installation of cold piping systems shall use oversize (outside the thickness of the insulation) pipe hangers.
  1. Piping systems 3" and smaller, the Insulation Contractor shall replace temporary wood blocking with insulation of thickness as scheduled in this section of the specification. Metal pipe shields shall be placed between the pipe hanger and the insulation.
  2. Piping systems 4" and larger, the Insulation Contractor shall replace the temporary wood blocking with high density pre-formed insulation (i.e. calcium silicate, cellular glass) inserts with suitable characteristics for the weight, temperature and application and insulation protection shields at each hanger. The specified insulation should stop and start at the insert at the hanger locations. The insert shall be wrapped with vapor barrier jacketing. Circumferential joints shall be taped with vapor barrier tape and coated with vapor barrier sealant. B-Line, or equivalent, figure B-3380 through B-3384, 360 deg. calcium silicate insert/shields and figure B-3153 protection shields may be used or equivalent may be field fabricated per details submitted for approval.
  3. If in the event pipe hangers are not oversized, this Contractor shall notify the Engineer and the Contractor(s) who provided and/or installed hangers. Hangers shall be corrected before pipe is insulated.
  4. Where size on size hangers have been approved by the Engineer in writing for use in special situations, the insulator shall insulate the hanger and hanger rod with ½" Type F insulation. Pipe insulation shall terminate at each side of the hanger and have vapor barrier end joint butt strips. Hanger insulation shall overlap pipe insulation a minimum of 4" on each side of the hanger and secured to the pipe insulation with contact adhesive. Hanger rods shall be insulated for a minimum of 12" secured to the rod with contact adhesive and the end sealed with a bead of caulk.
  5. The Contractor shall adjust hangers after the insulation and pipe shields have been installed to provide an evenly supported piping system. No hanger shall bear the entire weight or not carry any weight of piping system.
- H. Special requirements for fiberglass pipe insulation:
  1. Fiberglass pipe insulation, All Service Jacket/Self Sealing Lap (ASJ w/SSL) type, shall be installed with laps positioned to shed water, position at either 10 o'clock or 2 o'clock and shall not be visible to view. End joint butt strips shall be installed on all piping with ½" adhesive to adhesive overlap.
  2. For piping systems using fiberglass insulation, the fittings shall be insulated with: double thickness molded fiberglass fittings, or preformed cellular glass fittings secured with twine or wire; or with flexible elastomeric foamplastic; at the Contractor's option. The pre-molded PVC fitting covers shall be installed over the fiberglass inserts and secured with SS tacks. Victaulic fittings or couplings shall be insulated with sheet elastomeric foam plastic insulation formed to the fitting and formed "collars" over all couplings encountered.
  3. For piping systems using fiberglass insulation, butt joints in hot piping shall be made with 2" wide vapor barrier tape over butt joints. Butt joints in cold piping shall be made with a wet coat of vapor barrier lap cement on butt joints and seal joints with 2" vapor barrier tape. All pipe insulation ends shall be tapered and sealed.
  4. On "cold" applications only, the following additional requirements shall apply: the premolded fittings shall be sealed with an approved vapor barrier retardant prior to installing



the jacket materials. Premolded PVC fitting covers shall then be installed over the premolded inserts, all joints shall be sealed with vapor barrier cement and 2" vapor barrier tape on lap joints. Premolded stainless steel or aluminum fitting covers shall be installed per the manufacturer's instructions and a bead of clear silicon caulk applied to all joints. Straight lengths of insulation abutting all fittings shall have both ends sealed with vapor barrier cement to prevent "wicking" or moisture migration. At a maximum of twenty-one foot (21') intervals, joining ends of the butt joints shall be sealed with vapor barrier cement prior to butting together to prevent "wicking" or moisture migration.

- I. For piping systems using elastomeric foamplastic insulation, joints and seams shall be sealed with manufacturer's recommended contact adhesive. Fittings shall be insulated from segments fabricated from pipe insulation or sheet material, secured and sealed with contact adhesive. Termination points and ends shall be sealed to the pipe to prevent backflow of condensation on the inside of the insulation. Any piping outdoors or otherwise exposed to UV or ozone provide two (2) coats of WB Armaflex or Rubatex 374 finish.

#### 20 25 33 INSULATION APPLICATION - EQUIPMENT

- A. Manufactured equipment (i.e. air handling equipment, terminal units, air device plenums, etc.) requiring insulation shall be specified in the respective equipment specifications to be factory insulated with internally applied liner or double wall casing.

#### 20 25 34 INSULATION APPLICATION - DUCTWORK

- A. Ductwork systems shall be insulated in accordance with the insulation schedules. Insulate each duct section with single thickness full length pieces. Do not use scraps abutting each other.
- B. Extend insulation without interruptions through walls, floors, and similar penetration, except where otherwise specified.
- C. "Cold" duct systems shall have insulation with a continuous vapor retarder through all fittings, hangers, supports, air devices, fire dampers, duct mounted coils, dampers, and other devices in the ductwork system, etc.
- D. In "cold" duct systems, using rigid board or sheet elastomeric foam insulation, support angles, stiffener angles, ductmate flanges, etc. they shall be covered with an oversized insulation strip sized to provide the same insulation thickness as on the duct. Provide a minimum of 2" of overlap on each side of the obstruction.
- E. Board insulation shall be properly cut and dry fitted to the surface to be insulated. Edges shall be neat and clean cut. No intermediate cut pieces shall be allowed on the bottom and sides of the ductwork. Insulation board shall be secured in place using mechanical fasteners such as welded pins or speed clips. Locate not less than 3" from each edge or corner and approximately 12" on centers on all sides. There shall be a minimum of two (2) rows of pins on the bottom of the duct and one (1) on the sides. Additional pins may be needed on the bottom to prevent sagging. All seams, joints, penetrations and breaks in the vapor retarder jacket shall be sealed with pressure sensitive tape matching insulation facing. Edges shall be provided with 28 ga. 1" x 1" aluminum corner beading properly secured and shall have the same facing material as the insulation board.
- E. Flexible duct wrap insulation shall be cut properly and fitted to "stretchout" dimensions and a 2" piece of insulation removed from the facing at the end of the piece to form an overlapping staple and tape flap. Insulation shall be installed with facing outside so tape flap overlaps facing at the other end. Insulation shall be butted tightly. Seams shall be stapled on 6" centers with outward clinching staples. Adjacent sections of duct wrap insulation shall be butted tightly with the 2"

tape flap overlapping and stapled. For horizontal oval ducts over 30" wide, duct wrap insulation shall be secured additionally to the bottom of the duct with mechanical fasteners such as pins and speed clip washers spaced on 18" centers to prevent sagging. All seams, joints, tears, punctures and other penetrations in the vapor retarder jacket shall be sealed with FRK backing pressure sensitive tape.

- G. Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation.
- H. Where a duct run changes from interior lining to exterior application (or vice versa), there shall be a 6" overlap of insulation.
- I. In "cold" duct system with internal duct insulation, with 1 1/2 " thickness flexible duct wrap, insulate air devices, fire dampers, duct mounted coils, dampers, and other devices in the ductwork system that are not internally insulated.

END OF SECTION  
071588.002

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## **21 00 00 FIRE PROTECTION SYSTEM**

### 21 00 01 GENERAL

- A. This section specifies a hydraulically calculated fire protection system designed and installed by the Contractor as described on the drawings and hereinafter.
- B. It is the intent that the drawings and specifications shall describe and provide for a working installation complete in every detail and all items necessary for such complete installation shall be furnished whether specifically mentioned or not.
- C. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Divisions 20 - 29 of the Specifications.
- D. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 20 - 29 of these Specifications.

### 21 00 02 REFERENCES, REGULATORY REQUIREMENTS

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20 in addition to the following:
  - 1. National Fire Protection Association (NFPA) 13.
  - 2. UMC Campus Code Enforcement.
  - 3. Owner's Insurance carrier.

### 21 00 03 REFERENCES, RELATED SECTIONS OF THE SPECIFICATIONS

Requirements of the following Sections of the Specifications apply to Work for this Section:

- A. Division 20 - Basic Mechanical Conditions.
- B. Division 20 - Basic Mechanical Materials and Methods

### 21 00 04 DEFINITIONS

- A. The term **"layout"** where used in this Section of the Specifications shall mean drawings prepared by the Contractor showing where all piping and heads are located. These drawings should include pipe elevations, need not include pipe sizes and should not include hydraulic calculations.
- B. The term **"Authority Having Jurisdiction"** or **"AHJ"** where used in this Section of the Specification shall mean the organization, office, or individual responsible for approving equipment, an installation, or a procedure.
- C. The term **"rhythm"** where used in this Section of the Specifications shall mean spaced in a manner which would place the heads at the same location with respect to lights or diffusers (i.e., for a row of lights spaced at 12' centers heads shall also be on 12' centers so that the heads will remain the same number of ceiling tiles or distance away from the lights; where there is an odd number of tiles between lights or diffusers, it is also preferable to have heads located at the tile centered between them).

- D. The term “**working drawings**” where used in this Section of the Specifications shall mean drawing of the quality and containing all information as which would be required for approval by local official and for field construction.

21 00 05 WORK INCLUDED

- A. Furnish material, labor and services necessary for and incidental to the installation of the following systems where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications (Subsection 21 00 03 to perform the Work completely.
- B. Furnish and install a complete hydraulically engineered extension of the building fire protection system including the relocation of existing heads on existing branch lines.
  - 1. Hydraulic calculations shall include the domestic water demand in all common piping back to the point of the flow test.
- C. Verify actual water supply with a test, preferably witnessed or performed by the local fire official.
- D. Contractor shall coordinate his work with the work of other trades, and with the architectural and structural drawings.

21 00 06 SUBMITTALS

- A. The Contractor shall prepare submittals for approval in accordance with Subsection 20 00 43, Duties of Contractor - Submittals.
- B. Submit “Layout drawings” and equipment cut sheets with 30 days from the General Contractor’s contract date.
- C. Contractor shall submit “Working drawings” coordinated with the other trades for review prior to any fabrication or installation and prior to the General Contractor’s fourth partial pay request.
- D. Fire sprinkler shop drawings shall be submitted for review and approval prior to installation. The plans will be reviewed by: Maintenance Engineer/MU Fire Protection shop, City of Columbia Fire Marshal, and Design Engineer. Consequently, the submittal must be submitted in a timely manner; review duration shall exceed the submittal review duration noted in Division 20.

21 00 07 SPECIAL REQUIREMENTS

- A. The Contractor preparing the drawings and calculations shall be NICET Level 3 certified or a Professional Engineer licensed in the State of Missouri whichever is required by the Authority Having Jurisdiction.
- B. All equipment shall be U.L. Listed or F.M. approved for use in fire protection systems.
- C. Where Pipe and accessories installed under this section of the specification tie-in to existing systems, Contractor shall verify existing lines for: sizes, direction of flow (via pressure or physical tracing of piping, not labels), materials, and elevations before installing new work. Contractor shall notify Architect/Engineer upon discovery of discrepancy. Work performed prior to verification will be corrected at no cost to Owner.

21 00 08 CLOSE-OUT REQUIREMENTS

- A. Reference Section 20 00 48.

- B. Where NFPA maintenance information is utilized, it shall be edited to contain only information that is relevant to this project.

## **21 00 10 DESIGN**

### 21 00 11 WATER SUPPLY

- A. The water supply shall be a connection to the City water supply.
- B. A new flow test witnessed by the Fire Marshal shall be conducted.
- C. This information is provided for general information only.
- D. In sprinkler system that has fire pumps to meet standpipe requirements the sprinkler calculations shall not include the use of the fire pump. They shall be based upon the local water supply flowing through the bypass around the fire pump.
- E. Design water pressure requirements shall include a minimum of [10-psi] safety factor. Where Authority having jurisdiction requires a higher safety factory it shall be used.
- E. The point of this Contractor's work shall start where determined by the "General Contractor" and local trade practices.

### 21 00 12 LAYOUT - GENERAL TO ALL SPRINKLER SYSTEMS

- A. The "layout" shall be submitted to the Architect prior to performing hydraulic calculation, sizing pipes or seeking approvals from the authority having jurisdiction.
- B. The Architect/Engineer will review "layout" for aesthetics, and pipe routings for consistency with the construction documents.
- C. Minimum head spacing shall be as per NFPA-13., additional heads may be required by the Architect/Engineer to create spacing that works with the reflected ceiling plans. Contractor shall layout any areas not shown on the plans with symmetry and "rhythm" in mind.
- D. Heads shall be on return bends and centered  $\pm 1"$  for 2' x 2' ceiling tiles, or on quarter points  $\pm 1"$  for 4' x 2' ceiling tiles.
- E. Contractor shall not scale the drawing, refer to architectural drawings for dimensions. Where the room dimension is at the maximum size listed for the sprinkler heads, install an additional row of sprinklers.
- E. Contractor shall locate heads in the field from the final wall locations. It shall be brought to the Architect's/Engineer's attention where the center of tile location exceeds the maximum distance of the sprinkler. Additional heads shall be added and the layout modified as directed by the Architect/Engineer at no additional cost to the Owner.
- G. All sets and rises shall be located above ceilings of adjacent spaces of rooms without ceilings as opposed to making the sets and risers in the exposed spaces.
- H. Inspector test connections and auxiliary drains shall be piped to spaces not occupied by building occupants, i.e., Mechanical Rooms, Storage Rooms, Janitor's Closets, etc.

### 21 00 13 APPROVALS

- A. Submittal drawings shall show lights, ducts, and pipes indicating all necessary rises and drops in sprinkler piping required for routing. Drawings shall be of a minimum of the same scale as the contract documents ( $\frac{1}{4}'' = 1'-0''$  scale.). A  $\frac{1}{4}''$  scale drawing of the service entrance and an elevation of the service entrance shall be required. A sprinkler riser diagram showing all control valves, test connections, supervisory switches, and drains shall be required.
- B. The "layout" submittals shall be provided as PDF drawings of the piping layout. Equipment cut sheets shall also be provided at this time.
- C. Any pipe sizing or hydraulic calculations performed prior to the Contractor receiving the "layout" submittal with the 'approved stamp' of the Engineer shall be at the Contractor's own risk. Any design changes resulting in resizing pipe and/or revising hydraulic calculations will be done at no cost to the Owner.
- D. The "working drawing" submittals shall be provided as PDF drawings of the piping layout and include hydraulic calculations. Calculations shall include peaking information for each area calculated. The hydraulic calculation used for the system design shall be clearly identified from all other hydraulic calculations and should show the safety factor the designed system has relevant to the available water test pressure.
- E. Hydraulic calculations shall include: actual pipe internal diameters and coefficients of materials approved in the "layout" submittal; design density; remote area size; and area per sprinkler.
- F. The Contractor shall not pursue any approvals or interpretations of the design documents except through the office of the Architect/Engineer.
- G. All work shall meet the requirements of the Owner, authority having jurisdiction, Owner's insurance underwriter, Architect and Engineer. These requirements may be greater than required by NFPA. Work shall not start prior to the Contractor receiving the "working drawing" shop drawings with the 'stamp' of the Engineer and approval from the authority having jurisdiction.

### 21 00 14 TESTING

- A. Preliminary testing witnessed by the Architect/Engineer shall be conducted to assure proper operation before the final test is scheduled. Prior to this testing, pipes shall be flushed, hydrostatically tested, and all valves and devices shall be operated. All requirements of "System Acceptance" of NFPA 13 shall be met in full.
- B. The sprinkler system shall be final Acceptance tested in the presence of the Owner's Representative and the governing agencies having jurisdiction for approval.

### 21 00 15 ACCEPTANCE

- A. .Acceptance test performed as described above.
- B. Contractor shall fill out completely and sign Contractor's Material and Test Certificate provided in NFPA-13 and submit to Engineer for approval and thus system acceptance.
- C. Spurious Alarms
  - 1. If the Owner experiences an unacceptable number of spurious or unexplained false alarms during the installation and guarantee periods, the Contractor shall be responsible

for providing the necessary labor, material and technical expertise to correct the problem to the satisfaction of the Owner.

2. Any spurious alarms associated with waterflow devices or valve supervisory switches, range hood and duct fire suppression system monitoring devices, or monitoring of special suppression systems are considered unacceptable.
3. The Contractor shall coordinate with the fire alarm contractor to resolve spurious or unexplained false alarms.

**D. Keys and Special Tools**

1. The Contractor shall supply the Owner with three complete sets of any special tools or keys necessary for normal operation and maintenance of the system. Keys and locks for equipment shall be identical.

**21 00 16 SPACE CLASSIFICATION**

- D.** The most stringent of NFPA-13, local practices, or the following criteria shall be used in the sprinkler system design and hydraulic calculations.

- 1) Ordinary Hazard, Group 1:

Mechanical Rooms

- B. The hazard protection level shall be increased as required for areas with hazardous materials, flammable and combustible liquids, or storage that requires additional protection per NFPA 13. The sprinkler design criteria for spaces with hazardous materials and/or flammable and combustible liquids shall be in accordance with NFPA 30 and the requirements for Extra Hazard occupancies of NFPA 13.
- C. Reduction in design area shall be permitted for quick response sprinklers in accordance with NFPA 13.

**21 00 20 PIPING AND ACCESSORIES**

**21 00 21 VALVES**

- A. All valves shall be UL listed or F.M. approved and rated for 175 psi and listed for use in fire protection systems.
- B. Zone valves shall be, flanged or groove-end, UL 262 OS&Y gate valve or UL 1091 butterfly valve with manual gear operator, position indicator, and integral tamper switch.
- C. Drain valves shall be MSS SP-80, Type 2, Class 125 minimum, threaded or groove-end rising stem globe valve.
- D. Check valves shall be UL 312 flanged or groove-end swing check. Where used on fire department connections, valve shall have integral ball drip.
- E. Flow test and drain valve shall be a ball valve with sight glass. Valves shall be Guardian #9215 or equivalent.



## 21 00 22 PIPING MATERIAL AND FITTING SCHEDULE

- A. Size: 2-1/2" and larger above grade.
  - 1. Pipe: Schedule 40 seamless steel piping with bacterial resistant internal coating.
  - 2. Fittings: Butt-welded, groove-end, forged steel flanged, thread-o-let, weld-o-let.
  - 3. Joints: Butt welded, groove-end couplings, flanged.
  - 4. Tests: Hydrostatically at not less than 200 psi for two (2) hours per NFPA 13, Section 8-2
  
- B. Size: 2" and smaller above grade.
  - 1. Pipe: Schedule 40 seamless steel piping with bacterial resistant internal coating.
  - 2. Fitting: Cast iron or malleable
  - 3. Joints: Screwed, groove-end.
  - 4. Tests: Hydrostatically at not less than 200 psi for two (2) hours per NFPA 13, Section 8-2.2.
  
- C. Longitudinally welded black steel pipe must be installed with the weld line at least 45 degrees in relationship to the floor (for reference, the weld line points at the floor at 0 degrees).

## 21 00 23 FLEXIBLE HOSES

- A. Flexible hoses shall not be allowed in this project. Contractor to provide hard piped return bends for all sprinkler heads.

## **21 00 30 WET PIPE SPRINKLER SYSTEM**

### 21 00 31 SPRINKLER HEADS

- A. All sprinkler heads are to be quick response liquid in glass bulb type, with a minimum of 1/2 inch orifice, 1/2 inch NPT, and a K factor of 5.65. Sprinklers have an orifice larger than 1/2 inch shall be 3/4" NPT.
- B. In finished spaces with ceilings, concealed sprinklers with an adjustable white coverplate shall be used. Heads shall be equivalent to the Viking model Horizon Mirage, Tyco RF-II or Reliable model G4QR.
- C. In unfinished spaces or in concealed locations, upright and pendent sprinkler heads with a natural bronze finish shall be used. Heads shall be equivalent to the Viking Microfast Model M, Reliable model F1FR, or Tyco TY-FRB.
- D. In finished spaces without ceilings the heads shall be the same as above with the addition of a white factory finish.
- E. Sidewall sprinklers where utilized in Unobstructed Construction shall be horizontal recessed type with a white factory finish. Heads shall be equivalent to Viking Microfast model M, Reliable HSW-1, or Tyco TY-FRB.
- F. Sprinklers located in other locations where they are likely to be damaged shall be furnished with wire guards.

- G. Temperature range and response time shall be suitable for the location and the expected heat release. Within a space all sprinklers should be the same Temperature Range and Response Time to avoid “skipping”.
- H. Stabilizing brackets must be included in the installation of all sprinkler heads.

END OF SECTION  
071588.002

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## **23 00 00 HVAC PIPING AND EQUIPMENT**

### **23 00 01 GENERAL**

- A. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Division 20 of the Specifications.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Division 20 of these Specifications.

### **23 00 02 REFERENCES, REGULATORY REQUIREMENTS**

- A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc., as identified in Division 20.

### **23 00 03 REFERENCES, RELATED SECTIONS OF THE SPECIFICATIONS**

Requirements of the following Sections of the Specifications apply to Work for this Section:

1. Division 20 - Basic Mechanical Conditions and Basic Mechanical Materials and Methods
2. Division 24 – Air Distribution
3. Division 23 - Temperature Controls

### **23 00 04 DEFINITIONS**

(none)

### **23 00 05 WORK INCLUDED**

- A. Furnish material, labor and services necessary for, and incidental to, installing the following systems where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications (Sub-section 23 00 03 to provide for complete systems.
  1. Cooling system including, but not limited to, piping, piping specialties, pumps.
  2. Heating system including, but not limited to, heat exchanger(s), piping, piping specialties, pumps, relief valves, air separator and expansion tank.
  3. Air handling equipment including, but not limited to, central station air handling units, exhaust fans, and coils.
  4. Make-up water connections including, but not limited to, piping, and backflow preventers.
  5. Draining, filling, and venting of all modified systems as required for the above work. This includes scheduling shutdowns with the Owner (Refer to Section 20 10 70).
  6. All seismic restraints for the above work (Refer to Section 20 10 40).
  7. Smoke stopping of all penetrations of pipes and ductwork, and firestopping of the same through fire rated partitions as shown on the Architectural drawings including, but not limited to stairways, shafts, corridors, floors, roofs, and required exits (Refer to Section 20 10 20).
  8. Cleaning and pressure testing equipment, piping, and accessories installed under this section of the specification. (Refer to Section 20 10 50).
  9. Provide sufficient labor and resources required for the testing and balancing (Refer to Section 20 10 80) and for the commissioning process.

10. Installing accessories specified under other sections of the specification referenced in Sub-section 23 00 05, including but not limited to, control valves, thermowells, and taps for pressure sensors.

**23 00 06 SUBMITTALS:**

- A. The Contractor shall submit the following for approval in accordance with Subsection 20 00 43, Duties of the Contractor - Submittals.
  1. Piping materials, valves, and accessories as specified in Piping Materials Schedule(s) in this section of the specification.
  2. All specialties including, but not limited to, thermometers, gauges, relief valves, pressure regulators, backflow preventers, flow switches, and vacuum breakers.
  3. All HVAC equipment specified in this Division 23 including, but not limited to, heat exchangers, pumps, air handling units, and fans.
  4. All general items specified under Division 20 utilized in the installation of work required by this section of the specification.
- B. Provide manufacturer's technical product data of each material and accessory item with engineering support information, installation manual, operation and maintenance manual. Data shall be specific to product specified and clearly identified on all data sheets, which contains multiple models or sizes.
- C. At the point where the mechanical system has been installed and checked by the Contractor and the systems are ready for testing and adjusting, submit a letter to the Architect/Engineer stating such. Refer to Section 20 10 85.
- D. At the completion of the project, submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.

**23 10 00 HYDRONIC PIPING**

- A. Itemization of the piping materials for specific system application are enumerated in the following sub-sections for the respective PIPING MATERIAL SCHEDULE. Specific requirements for materials shall be as listed in Division 20 Basic Materials and Methods.
- B. Manufacturer's mill reports and applicable documents to certify the validity of the procured piping materials shall be on file at the Contractor's office.
- C. Install all piping with pitch to vent or drain. Provide drain valves at low points and air vents at high points. Drain valves and air vents shall be  $\frac{3}{4}$ " bronze 2 piece body ball valves with  $\frac{3}{4}$ " hose end adapter, cap and chain. In  $\frac{1}{2}$ " through 2" pipe, contractor may use Webstone model T-drain. Use eccentric reducing fittings (installed top level) as required to avoid air pockets.
- D. Gaskets and packings containing asbestos are not acceptable.
- E. Where Pipe and accessories installed under this section of the specification tie-in to existing systems, Contractor shall verify existing for: sizes, direction of flow (via pressure or physical tracing of piping, not labels), materials, and elevations before installing new work. Contractor shall notify Architect/Engineer upon discovery of discrepancy. Work performed prior to verification will be corrected at no cost to Owner.

23 10 01 PIPING MATERIAL SCHEDULE, M-1

- A. Service: Chilled water supply and return for HVAC.  
Hot water (heating) supply and return for HVAC.  
Glycol run-around energy recovery loop piping.
- B. Rating: 125 psig at 350°F  
175 psig at 150°F
- C. Pipe: (Refer to Section 20 10 11)
1. 3" and smaller Copper, type L.
  2. 10" and smaller Black carbon steel, schedule 40, ASTM-A53, ERW.
- D. Fittings: (Refer to Division 20 10 10)
1. 3" and smaller Wrought copper, solder ends.
  2. 2-1/2" and smaller Cast iron, screwed.
  3. 3" and larger Black carbon steel, buttweld. Elbow fittings shall be long radius. See Division 20 10 00 for acceptable branch arrangement in lieu of tee fitting. Wall thickness consistent with connecting pipe.
- E. Joints in Steel Piping: (Refer to Division 20 10 30)
1. 2-1/2" and smaller Screwed
  2. 3" and larger Welded, except at connections to rotating equipment where (2) Style 177 couplings shall be used at each inlet and outlet connection.
  3. All sizes where concealed in chases or walls, or above gyp/plaster ceilings Welded
- F. Joints in Copper Piping (Refer to Division 20 10 30):
1. All 95/5 solder
- G. Valves: (Refer to Division 20 10 10)
1. Shut-off/service:
    11. 3" and smaller Ball valve: two piece bronze body, stainless steel ball and trim.
    12. 3" and larger Butterfly valve, ductile iron body.

13. Contractor has the option on 3" valve to use either ball valves or butterfly valves.
2. Balancing/Throttling:
  21. 12" and smaller Multi-turn calibrated balance valve.
3. Check valve – General Duty:
  31. All Class 125, swing check.
4. Check Valve – Pump Discharge:
  41. 2-1/2 and smaller Class 125, swing check
  42. 3" and larger Class 125, cast iron body, silent check
5. Unions:
  51. 3" and smaller Wrought copper, solder ends.
6. Flanges:
  61. 4" and smaller Cast copper companion type, solder end, class 125 ASME standard or class 150.
  62. 2-1/2" and larger 150 lb., Black forged carbon steel, weld neck pattern.
7. Pressure Test: Hydrostatic test at 200 psi for two (2) hours minimum.

23 10 02 PIPING MATERIAL SCHEDULE M-2

- A. Service: Make-up water for hydronic systems.
- B. Rating: 175 psig at 150°F
- C. Pipe: Type L copper
- D. Fittings: Wrought copper, solder ends.
- E. Shutoff/Service  
Valves: Ball valve: two piece, bronze body stainless steel ball and trim.
- F. Pressure Test: Hydrostatic test at 200 psi for two (2) hours minimum.

23 10 03 PIPING MATERIAL SCHEDULE M-3

- A. Service: Condensate drain piping.

- B. Design: Atmospheric
- C. Pipe: Type L copper
- D. Fittings: Wrought copper, solder ends. 90° elbows are not permitted, use (2) 45° elbows or 'Y' provided with cap in unconnected straight run.
- E. Extend piping from all cooling coil drain pans to the location of discharging indirectly to the building drain system. Pipe size shall be unit connection size unless indicated larger on the plans.
- E. Connections to the drain pans shall be made through a water seal trap with the downstream side vented to atmosphere.

#### 23 10 04 HYDRONIC SPECIALTIES

##### A. Automatic Flow Control Valve

1. Forged brass y-pattern body, stainless steel flow cartridge, and two (2) integral pressure/temperature test ports.
2. Flow cartridge shall be factory flow tested and calibrated to an accuracy of +/- 5% over a range of at least 5-40 PSI. Flow cartridge shall be inscribed with the designed manufactured flow rate.
3. The valve and flow cartridge shall both have a 5-year warranty.
4. Valve shall be Nexus model UltraMatic UMF or equivalent from Griswold.

##### B. Automatic Air Vent

1. Automatic air vents shall be furnished and installed for all centrifugal air separators. Automatic air vents shall be high capacity, float actuated, cast iron or cast brass body, stainless steel/brass trim and rated for 150 psi at 250°F.
2. Automatic air vents shall have their discharges piped to a drain.
3. Automatic air vents shall be Amtrol Model 720, Armstrong AAE-750, Bell & Gossett 107A, Spirotherm model Spirotop, Thrush model 720 or equivalent.

##### C. Safety Valves, Relief Valves, Safety Relief Valves

1. Pressure relief valves shall be furnished and installed for all heat exchangers, etc., and where shown on the plans, flow diagram, or details in all hydronic systems not containing boilers. Valves shall be factory set and field verified for 125 psi, bronze body, stainless steel trim and test/lift lever. Pressure relief valves shall be a minimum of ¾" Bell and Gossett Model 790, Watts 174A, Kunkle or equivalent.
2. Hydronic systems containing heat exchangers or other unfired heating vessels shall have safety relief valves sized for the rated output of each device at the pressure rating of the lowest pressure device. Valves shall be ASME Code Section VIII rated, bronze body and brass trim. Safety relief valves shall be Kunkle, Bell and Gossett, Watts or equivalent.
3. Discharges from valves shall be piped to floor drains for water valves.

##### D. Pump Flowline Fitting (Suction diffuser)

1. At all inlets to base mounted pumps furnish and install a flowline fitting with strainer. Fitting shall be coordinated with pump inlet size and system piping, where largest system



size available is smaller than the system piping, provide piping reducer at inlet of flowline fitting.

2. Fitting shall be 90° angle cast iron body with exit vane, 304 stainless steel strainer with ¼" openings, fine mesh start-up strainer, adjustable support foot, and drain connection.
3. Fitting for end suction pumps shall be Bell & Gossett, Armstrong, Taco or equivalent.
4. Fitting for double suction pumps shall be Flow Conditioning Corporation or equivalent.

E. Make-up Water Connection

1. At all make-up water locations to hydronic systems provide a line size reduced pressure backflow preventer, pressure reducing valve, water meter, and a pressure relief valve. In closed system the pressure reducing valve and water meter shall be ¾".
2. Backflow preventer shall be of reduced pressure type. Assembly shall include shut off valves, strainer and air gap connection. Backflow preventer shall be Watts Series 909 or equivalent.
3. Pressure reducing valves shall be furnished and installed for each system and field adjusted for each system to provide 10 psi at the highest point in the system with all pumps off for positive venting. Pressure reducing valves shall be Watts U5, Bell and Gossett #7, Taco 335, Armstrong HRD70 or equivalent.
4. Water meter 1" and smaller shall be a totalizing positive displacement meter indicating in U.S. Gallons meeting AWWA Standard C-700 latest edition. Meters shall be Neptune T-10, Kent C-700, or Hersey MTX 123, or equivalent.

F. Glycol Fill Unit

1. All-in-one glycol reservoir and pumping unit. 12-gallon polypropylene tank, steel frame, all bronze pump, and adjustable pressure setpoint pressure switch controller. Brass ball valves on the water fill and glycol fill connections.
2. Unit to be compatible with either propylene or ethylene glycol.
3. Unit to be Armstrong model GLA-S-HP-1 or equal.

G. Thermometers

1. Thermometer wells and thermometers shall be provided at the inlet and outlet of all air handling unit coils, etc., and where shown on the plans, piping isometrics, flow diagrams and details.
2. Thermometers shall be organic spirit filled in a 9" polyester or aluminum case, magnified lens, glass or acrylic front, black divisions and numbers. Accuracy shall be ± one scale division. Stem shall be tapered aluminum installed in a brass thermowell. Stem length and lagging length shall be coordinated with the piping and the insulation. A minimum 2" insertion length shall be in the moving fluid.
3. Thermometers for use in chilled water having 1°F increments are preferred with a minimum range of 30°F - 100°F, in no case shall the range be greater than 0°F - 160°F having 2°F increments.
4. Thermometers for use in heating water systems shall have 2°F increments with a range of 30-240°F.
5. The submittal data shall clearly identify the range and the service the thermometers are used for.
6. Thermometers shall be Weksler AS5, Trerice model Adjustable Angle, Weiss Vari-angle, MILJOCO 935, or equivalent.
7. Where thermometer wells are installed below 5 feet they shall be installed on the side of vertical piping or on the top of horizontal piping so that they can be angled back beyond

vertical to allow easy reading. Where thermometer wells are installed above 6 feet they can be installed on the face or the side of vertical piping and for horizontal piping it should be installed between 9 and 12 o'clock to allow the thermometers to be angled less than vertical without the pipe blocking the view of the thermometer.

8. Prior to installing the thermometer wells, the contractor shall have the thermometers at the jobsite and shall demonstrate to the Architect/Engineer where they intend to install them where they will be easy to read. If the Contractor fails to perform the above, any thermometers which are unreadable, in the opinion of the Architect/Engineer, it shall be modified at the Contractor's expense.

#### H. Test Ports

1. Provide pressure and temperature test plugs at locations shown on the plans, flow diagrams and details. Test ports shall be pressure and temperature test plugs. Plugs shall be self-sealing plugs. EPDM seals rated for the temperature, pressure and fluid associated with the application and shall be capable of accepting a needle type temperature or pressure probe and reclosing when the probe is removed. Furnish extensions for test ports installed in insulated piping. Plugs shall be provided with threaded protective caps. One temperature and pressure test kit suitable for the plugs used on the job shall be provided to the Owner on all installations where the plugs are used. Acceptable manufacturers and models are as follows:

Manufacturer	Model
Peterson Engineering	Pete's Plug
Trerice	Pressure/Temperature Test Plug
Sisco	P/T Plugs
Bell and Gossett	Read-out Valve RV-125A

2. Alternatively, access fittings may be provided in place of the Pete's Plugs. In this case, the fittings shall be provided with a retained cap and shall be Mueller Brass A-17130 or equivalent.

#### I. Gauges

1. Provide 1/4" ball valves gauge cocks at all inlet and outlet of air handling units and across control valves of air handling units and at the inlet and outlets of heat exchangers, pumps, etc., and where shown on piping isometrics, flow diagrams and details. Provide gauges where shown on piping isometrics, flow diagrams, and details.
2. Gauges shall be 4-1/2" diameter, flangeless aluminum/stainless steel safety case with removable ring, bottom connection, with a recalibrator, and have stainless steel tube and stainless steel movement calibrated to 1/2% accuracy, ANSI B40.1 Grade 2A with a pressure range appropriate for each system. Open water condenser systems shall have compound gauges. Gauges located at pumps shall be provided with a porous stone/metal type pressure snubber.
3. Gauges shall be Weiss Instruments UG2, Trerice 500XSS Series, Weksler AA44Y or equivalent by Marsh, or Marshalltown. Accessories from the same manufacturer shall be acceptable.
4. At pump locations utilizing factory taps in the casing or other locations where steel pipe is utilized, provide 1/4" brass screwed pipe and 1/4" 2-piece bronze threaded ball valve with lever handle for a gauge cock.
5. At locations where copper pipe is utilized, provide a 1/2" tee by line size connection in the piping and a 1/2" 2-piece bronze threaded ball valve, and 1/4" NPT bushing with lever handle for a gauge cock.

6. Gauges shall be installed as follows: 3" straight piping/nipple, service valve/gauge cock, tee with P/T plug in the run of the tee, and the gauge installed on the branch of the tee. There shall be no change in direction between the valve and the process pipe to allow cleaning an obstruction. The 3" is to create a dead leg to minimize sweating without insulating the valve.
7. All gauges shall be positioned where their view is unobstructed and can be easily read. If any gauge is unreadable, in the opinion of the Architect/Engineer, it shall be modified at the Contractor's expense.

#### 23 10 05 EXPANSION TANKS

- A. Furnish, install, and charge expansion tanks as indicated on the plans, flow diagrams, and schedules. The tanks shall be field charged by the Contractor to provide 10 psig at the high point of the system with all pumps not operating for positive venting.
- B. Expansion tanks shall be constructed in accordance with Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code and stamped for a minimum working pressure of 125 psi at 200°F. The tanks shall have a standard schrader charging valve (.302" – 32) connection for on-site adjustment of the system pressure. The tanks shall be provided with mounting hardware for either vertical base mount or saddles for horizontal mounting in the configuration shown or scheduled on the drawings.
- C. Diaphragm type tanks shall have a non-replaceable heavy duty butyl rubber diaphragm to separate the air charge and the system water. The minimum system connection size shall be ½" NPT. Diaphragm type tanks shall only be used when scheduled as such, otherwise expansion tanks shall be bladder type tanks. Diaphragm tanks shall meet or exceed both the minimum acceptance volume and total volume as scheduled.
  1. Diaphragm type expansion tanks shall be Amtrol AX Series, Bell and Gossett Series D, Taco CAX series, Thrush AX series or approved equivalent.

#### **23 21 40 PUMPS**

##### **A. General**

1. Furnish and install circulating pumps for water service of the base mounted or in-line configuration as scheduled on the drawings. Pumps shall be factory tested, aligned, painted, and shipped complete for installation. Electrical characteristics shall be as scheduled on the plans.
2. Piping at pumps shall be arranged to facilitate pump maintenance. Piping shall be arranged so that the service valves can be closed and the piping and specialties between the service valves and pump removed for servicing and to allow clear access to the pump for removal as required. Where pump connection sizes are smaller than the line sizes associated with the suction and discharge piping, concentric reducers or increasers shall be installed immediately at the pump flanges to adapt to the indicated line size. All specialties and service valves associated with the pump such as strainers, check valves, etc., shall be line size, and not pump connection size.
3. Where pumps are from manufacturers not scheduled the following criteria shall apply: Pumps shall be picked at scheduled flow and head with working fluid of the system which the pump is in, pump impeller shall not be within ½" of the smallest or largest size for the pump body, pump efficiency shall not more than 5% less efficient than scheduled pump, operation point shall not exceed nameplate horsepower, pump motor size shall not be larger than scheduled motor (Contractor can pursue equipment substitution as required in Subsection 20 00 51 for pumps with larger motors), pumps which are used in parallel

installations shall be sized such that the brake horsepower does not exceed the motor horsepower when only one pump is running. This operating point shall not be off of the manufacturers published pump curve.

4. Where existing systems are modified, provide start-up strainers at all existing pumps. Strainers shall be removed after 72 hours of operation.

#### 23 21 41 IN-LINE PUMPS

- A. General: In-line pumps and circulators shall be suitable for mounting in either vertical or horizontal piping with the motor mounted as specified below. Pumps shall be flanged and provided with a companion flange having NPT tapings or shall be ANSI Standard B16.1 flanges. Pumps shall have factory taps, shipped with plugs installed, for measuring suction and discharge pressure, and at the low point in the volute to allow draining. Where in-line pumps are installed in horizontal or vertical piping, the pump shall be rigidly mounted to the piping with pipe hangers on each side of pump, but the motor shall not be supported. Where in-line pumps are supported from the floor using a pipe stand/column then two flexible mechanical couplings shall be used on each side of the pump for vibration isolation.
- B. Horizontal in-line pumps shall be bronze or iron construction as scheduled. Pumps shall be horizontal (motor and shaft installed position) in-line type, oil lubricated, one-piece cast bronze impeller dynamically balanced, and flexible coupled. Pumps shall be rated for a maximum working pressure of 175 psi at 150°F and 150 psi at 250°F. Mechanical seals shall be two piece design with a carbon seal face and ceramic seat rated for continuous operation at 225°F. Pump shall be of a three-piece design consisting of: the volute, bearing module, and the motor; with each section bolted to the next. The bearing module shall have oil lubricated bronze journal and thrust bearings. The motor shall be joined to the pump shaft through a flexible coupling. Motors shall be NEMA B letter design with a 1.15 service factor, open drip-proof, premium efficiency. Provide variable speed pumps with TB Woods "Dura-flex" HP rated coupling.
- C. Pumps shall be Bell and Gossett series 60, Taco 1600 series, Armstrong series 1060, or approved equivalent.

#### 23 21 42 BASE MOUNTED END SUCTION PUMPS

- A. End suction base mounted circulating pumps shall be Class 30 ductile iron case construction allowing rear removal of bearing assembly and impeller without disturbing piping or motor alignment, dynamically balanced cast bronze impeller, replaceable bronze wear rings, mechanical shaft seal, heavy duty bearings for long service life on oversized steel shaft with replaceable bronze shaft sleeve connected to motor through a shielded flexible coupling designed to absorb minor misalignment and vibrations. Pumps shall be rated for a maximum working pressure of 175 psi at 150°F and 150 psi at 250°F (125# ANSI flange). Mechanical seals shall be flushed two piece design with a carbon seal face and ceramic seat rated for continuous operation at 225°F. Motors shall be NEMA B design letter with a 1.15 service factor, open drip-proof, premium efficiency. Pumps shall have factory taps shipped with plugs installed for suction pressure, discharge pressure, and at the low point in the volute to allow draining. Pumps shall be Bell and Gossett Series 1510, Armstrong Series 4030, Taco Model FI, Peerless Type F, or approved equal.
- B. INSTALLATION:
  1. Unit shall be installed on 3-1/2" concrete pad. Refer to Section 20 00 00 BASIC MECHANICAL CONDITIONS.

2. After installation of the base mounted pumps and anchoring the base in place, the Contractor shall fill the steel bases with grouting cement. Pump bases shall be grouted prior to the final alignment.
3. Refer to flow diagram and details for piping specialties for the pumps.
4. Following the completion of all piping connections, pump couplings and drives shall be systematically aligned using approved methods and instruments. Before putting the pumps into service, the alignment shall be approved by the Architect/Engineer.

## **23 22 00 STEAM PIPING MATERIALS**

- A. Itemization of the piping materials for specific system application are enumerated in the following sub-sections for the respective PIPING MATERIAL SCHEDULE. Specific requirements for materials shall be as listed in Division 20 10 00 Basic Materials and Methods.
- B. Manufacturer's mill reports and applicable documents to certify the validity of the procured piping materials shall be on file at the Contractor's office.
- C. Install all piping with pitch to vent or drain. Provide 150 pound ball valves with hose end adapter at all low points and manual key operated air vents at all high points. Use eccentric reducing fittings (installed bottom level) as required to avoid air pockets.
- D. Steam systems shall be defined as: low pressure when operating between 0-15 psig, medium pressure when operating between 16-50 psig, high pressure when operating above 51 psig.
- E. In steam systems service valves and strainers shall be installed with the stem/basket in the horizontal position so that condensate flow is not impeded.
- F. Install pigtail siphon at all pressure gauge and pressure transmitter locations. Refer to Section 23 10 09 for gauge specifications.
- G. Gaskets and packings containing asbestos are not acceptable.

### 23 22 01 PIPING MATERIAL SCHEDULE M-4

- A. Service: Steam supply: Low pressure, steam vents
- B. Rating: 125 psig at 350°F.
- C. Pipe:
  1. 10" and smaller Black carbon steel, Schedule 40, ASTM-A53, ERW.
- D. Fittings:
  1. 2" and smaller Cast iron, screwed, 125#.
  2. 2-1/2" and larger Black carbon steel, buttwelded, standard schedule.
- E. Valves:
  1. Shut-off/service:
    - a. 2" and smaller Gate valve, Class 125, bronze body.
    - b. 2-1/2" thru 12" Gate valve, Class 125, iron body.

- 2. Balancing/Throttling:
  - a. Globe valve, Class 125, bronze body.
  - b. 2-1/2" thru 10" Globe valve, Class 125, iron body.
- E. Flanges: 150 lb., black forged carbon steel, weld neck pattern.
- G. Pressure Test: Hydrostatic test at 200 psig for two (2) hours minimum.

23 22 02 PIPING MATERIAL SCHEDULE M-5

- A. Service: Condensate return (all types)
- B. Design: 125 psig. (Max) temperature: 220°F
- C. Pipe:
  - 1. 5" and smaller Black carbon steel, Schedule 80, ASTM-A53, ERW. At Contractor's option for long runs without equipment connection Type L copper pipe may be used.
- D. Fittings:
  - 1. 2-1/2" and Extra heavy 250 lb., threaded cast iron
  - 2. 3" thru 5" Black carbon steel, buttwelded, Schedule 80
- E. Valves:
  - 1. Shut-off/service:
    - a. 2" and smaller Gate valve, Class 125, bronze body
    - b. 2-1/2" and larger Gate valve, Class 125, iron body
  - 2. Check Valve:
    - a. 2" and smaller Swing check, Class 125, bronze body
- F. Flanges: 150 lb., black forged carbon steel, weld neck pattern.
- G. Pressure Test: Hydrostatic pressure test at 150 psig for two (2) hours minimum.

23 22 07 STEAM SPECIALTIES

- A. Vacuum Breaker (Steam Heat Exchangers):
  - 1. Furnish and install at all heat exchangers and entering side of steam coils a vacuum breaker rated for a maximum working pressure of 150 psig and 366°F operating temperature.
  - 2. Vacuum breakers shall be Bell and Gossett No. 26, or approved equal.
- B. Float and Thermostatic Traps (Modulation Loads):
  - 1. Float and Thermostatic Traps: ASTM A126, cast-iron body and bolted cap; renewable, stainless steel float mechanism with renewable, hardened stainless-steel head and seat; maximum allowable pressure of 125 psig; balanced-pressure, stainless-steel or monel thermostatic bellow element. Thermostatic air vent capable of withstanding 45°F of superheat and resisting water hammer without sustaining damage.
  - 2. Steam traps shall be Hoffman, Armstrong, Spirax Sarco, or Watson McDaniel.

3. See schedule for sizes, capacities, and operating pressures.

## **23 57 00 HEAT EXCHANGERS**

### **A. General**

1. Furnish and install heat exchanger of the type, size, and arrangement as specified herein and as scheduled on the drawings.
2. Provide mounting hardware and steel frame as necessary for installation.

### **23 57 01 SHELL AND U-TUBE – BUILDING HEATING WATER**

- A. Steam to water heat exchanger shall be constructed according to ASME Section VIII, Division 1 and shall be rated for 75 psi, 350°F steam in the shell and 150 psi, 300°F water in the tubes.
- B. Heat exchanger shall have steel shell; 150 psi removable cast iron, cast bonnet head; 300 psi iron, cast bonnet head; removable tube bundle; brass tube sheet;  $\frac{3}{4}$ " copper tubes; brass tube supports; and brass baffle plates.
- C. Heat exchanger shall be Bell and Gossett Type QSU, Armstrong Type WS, Taco GS Series or approved equivalent.

## **23 73 00 AIR HANDLING UNITS**

### **23 73 01 CUSTOM DOUBLE WALL UNITS**

- A. Furnish and install air handling units as specified below, and as described in air flow diagrams and schedules on the mechanical drawings. The unit shall include frame casing, insulated drain pans, coils, control dampers, fan assemblies, access panels for easy access to all service points, bearings, motors and drives and guards.
- B. The units shall be constructed of welded or bolted angle or channel steel frames. The casings shall be a minimum of 20 ga. G90 galvanized sheet metal. The panel shall be 2" double wall foam R-13 with thermal break. The entire frame assembly shall be hot dipped galvanized after fabrication, or suitably treated with a rust inhibitor coating. The interior of the casing shall be entirely aluminum.
- C. Hinged access doors with camlocks and heavy-duty hinges shall be provided for ready access to bearings, motors, drives, coils, piping devices and connections, and other points required for maintenance service or inspection. Condensate drain pans shall be installed with 2" of insulation provided between the drain pan and the casing; units with multiple vertically stacked coils shall have an intermediate drain pan. The pans shall be of continuously welded seams, Series 300 stainless steel construction, 'V' shaped and/or sloping to the drain connection, flat pans will not be acceptable. Drain pans shall be located in the cooling coil section.
- D. Entire air handling unit shall set on base rails to allow deep condensate trap and where shown on the plans. Base rails shall be a minimum of 8" height where no size is indicated on the plans.
- E. Unit shall include a magnhelic gauge per filter bank. Refer to the filter specification section and schedule on the mechanical drawings for additional details.

- F. Fans shall have capacities and minimum wheel diameters as indicated on the schedules. Each fan shall be of the non- overloading centrifugal type with deep drawn inlet rings, streamlined housing and scroll, with blades continuously welded to the flange, solid backplate, full curved shroud, and flanged discharge collar. Supply fan shall be direct drive plenum type. Fan bearings shall be heavy duty, self-aligning, grease lubricated, antifriction type with double row rollers and labyrinth grease seals. Fans and motors shall be resiliently mounted on a single structural base, internally mounted with resilient mounts on the unit structural frame. Internal resilient mounting shall be spring type with minimum 1-1/2" static deflection and provided with seismic restraints. Each fan shall be independently supported.
- G. Manufacturer to provide pick rail in the fan section of the unit that allows for lifting of any of the fan motors when a replacement is required.
- H. The manufacturer shall use the most energy efficient fan option within the manufacturer's line for the unit size but in no case will the wheel be smaller than the diameters scheduled.
- I. The units shall be provided with coils (cooling, pre-heat, and re-heat) of the types and capacities scheduled. Fins shall be permanently secured to the tubes by mechanical bonding or soldering and shall be plate type. The frame shall include intermediate tube supports to prevent sagging of the tubes. The coil shall be removable with removing casing panels (i.e., casing shall have its own internal frame and shall not use the coil for support).
- J. All coil casings shall be copper. Coils shall be constructed with no less than 5/8" diameter x .025" wall thickness copper tubes and .006" thick copper fins spaced not closer than indicated on equipment schedule. The number of rows shall not be less than scheduled on the equipment schedule. Coil construction of dissimilar metals shall not be acceptable.
- K. Coils connections shall be NPT red-brass.
- L. Coils performance shall be AHRI 410 certified. Submittals shall include AHRI certified reference number. Coils shall be tested for 250 psig under water and shall be guaranteed for 200 psig working pressure.
- M. Water coil headers and "U" bends shall be arranged so that the entrained air is carried along with the flow of water through the coil to the high point on the leaving water header. High points in the coil shall be provided with vent connections. Multi-row coils shall be arranged for counterflow heat exchange between the air and water.
- N. Air handling units shall have marine lights in each section. Single point power connections, 12x12 windows in access doors. There shall be one external light switch and receptacle.
- O. Lighting and service receptacles shall come prewired. Wire shall be run in conduit according to the electrical specification.
- P. All access doors to any moving mechanical equipment shall be provided with door switches.
- Q. Unit shall come with return, outside and supply air duct openings as shown on the mechanical drawings.
- R. Unit shall come with return air control dampers Ruskin model CD-50 (aluminum, airfoil, opposed blade). Refer to the air flow diagram for actual location. Return air bypass air damper shall be sized for 1800 to 2000 FPM. Modulating actuator for control damper to be provided by controls contractor.
- S. Unit shall come with two outside air controls dampers Ruskin model CD-50 (aluminum, airfoil, opposed blade): one sized for minimum outdoor air flow (5000 CFM) and one sized for the



- remainder of the airflow when doing economizer mode (10,000 CFM). Refer to the air flow diagram for actual location. Modulating actuator for control damper to be provided by controls contractor.
- T. Unit shall come up 2" insulated divider wall from return air damper to cooling coil to make bypass air path. Refer to the air flow diagram for additional information.
  - U. Unit shall be provided from factory in (3) pieces and require to be put together on site. Mechanical contractor to verify the path prior to ordering. Reach out to mechanical engineer with any issues prior to ordering the unit.
  - V. The following tests shall be performed in the fully assembled air handling unit prior to shipment by factory and in the field after the unit is fully assembled by the mechanical contractor. The report shall be furnished to the engineer. Unit air leakage shall not exceed 1.0% of design cfm at +10.0" w.g in all positive-pressure sections and -10.0" w.g in all negative-pressure sections. Leakage shall be calculated by totaling all leakage either in to or out of the unit.
  - W. The units shall be Trane model TCFS or approved equal.

END OF SECTION  
071588.002

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## **23 09 00 CONTROL SYSTEMS**

### **PART 1 GENERAL**

#### **1.01 SUMMARY**

- A. University of Missouri Controls Specification.
- B. This section contains requirements for pneumatic, electric and digital control systems as indicated on the contract drawings.
- C. Contractor is responsible for providing, installing and connecting all sensors, pneumatic actuators, control valves, control dampers, electrical components and all interconnecting pneumatic tubing and electrical wiring between these devices and up to the Direct Digital Controller (DDC).
- D. DDC systems consist of Johnson Controls METASYS controllers. Contractor shall install owner provided control enclosures. Owner will provide and install controllers. After all equipment has been installed, wired and piped, Owner will be responsible for all termination connections at the DDC controller's and for checking, testing, programming and start-up of the control system. Contractor must be on site at start-up to make any necessary hardware adjustments as required.
- E. Once each mechanical system is completely operational under the new control system, contractor shall make any final connections and adjustments. For controls renovation jobs, contractor shall remove all unused sensors, operators, panels, wiring, tubing, conduit, etc. Owner shall have the option of retaining any removed pneumatic controls.

#### **1.02 RELATED SECTIONS**

- A. Drawings and general provisions of Contract, including General and Special Conditions apply to work of this section.

#### **1.03 QUALITY ASSURANCE**

- A. Contractor's Qualifications:
  - 1. Contractor shall be regularly engaged in the installation of digital control systems and equipment, of types and sizes required. Contractor shall have a minimum of five years' experience installing digital control systems. Contractor shall supply sufficient and competent supervision and personnel throughout the project in accordance with General Condition's section 3.4.1 and 3.4.4.
- B. Codes and Standards:
  - 1. Electrical Standards: Provide electrical components of control systems which have been UL-listed and labeled, and comply with NEMA standards.
  - 2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for control systems.
  - 3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

4. NFPA Compliance: Comply with NFPA 70 "National Electric Code."

## 1.04 SUBMITTALS

- A. Shop Drawings: Submit shop drawings for each control system, containing the following information:
- B. Product data for each damper, valve, and control device.
- C. Schematic flow diagrams of system showing fans, pumps, coils, dampers, valves, and control devices.
- D. Label each control device with setting or adjustable range of control.
- E. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- F. Provide details of faces on control panels, including controls, instruments, and labeling.
- G. Include written description of sequence of operation.
- H. Provide wiring diagrams of contractor provided interface and I/O panels.
- I. Provide field routing of proposed network bus diagram listing all devices on bus.

## PART 2 PRODUCTS

### 2.01 MATERIALS AND EQUIPMENT

- A. Air Piping:
  1. Copper Tubing: Seamless copper tubing, Type M or L, ASTM B 88; wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment.
  2. Flex Tubing: Virgin Polyethylene non-metallic tubing, ASTM D 2737, with flame-retardant harness for multiple tubing. Use compression or push-on polyethylene fittings. Tubing used above suspended ceilings to be plenum rated per NFPA 90A. See section 3.1.b for locations where flex tubing can be used.
  3. Copper to polyethylene connections shall be compression barbed fittings or solder barbed fittings.
- B. Conduit and Raceway:
  1. Electrical Metallic Tubing: EMT and fittings shall conform to ANSI C80.3.
  2. Surface Metal Raceway and Fittings: Wiremold 500, Ivory, or approved equal.
  3. Flexible Metal Conduit: Indoors, per National Electric Code for connection to moving or vibrating equipment.
  4. Liquidtight Flexible Conduit: Outdoors, per National Electric Code for connection to moving or vibrating equipment.
- C. Control Valves: Provide factory fabricated electric control valves of type, body material, and pressure class as indicated on the drawings. Butterfly style control valves are not acceptable except for two position applications. Equip control valves with heavy-duty actuators, with proper shutoff rating for each individual application.
  1. Hydronic Chilled Water and Heating Water
    - a) At minimum, hydronic control valves shall be pressure independent. High

performing energy monitoring control valves may be considered depending on the project. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valve shall accurately control the flow from 1 to 100% full rated flow.

- b) The valve bodies shall be of cast iron, steel or bronze and rated for 150 PSI working pressure. All internal parts shall be stainless steel, steel, Teflon, brass, or bronze.
  - c) DeltaP Valves manufactured by Flow Control Industries, Belimo, Danfoss Series, or approved equal.
  - d) The valves shall have pressure taps across the valve for measuring the pressure drop across the valve. The pressure taps shall have ½-inch extensions for accessibility.
  - e) Control valves shall be installed with unions or flanges as necessary for easy removal and replacement.
  - f) Valve Tag shall include the model number, AHU being served, design flow, and maximum flow for that valve.
  - g) The control valves shall be delivered preset to the scheduled design flow and should be capable of reaching 110% of the design flow to allow for field adjustment for capacity changes.
  - h) Control valves shall have a minimum 100 psi close-off rating.
2. Preheat Coils
- a) At air handling unit preheat coils where unconditioned outdoor air is at least a partial component of the air stream, the coil shall be pumped, and an automatic control valve shall be used to maintain design coil flow. In order to avoid the automatic control valve and control valve from fighting, a non-pressure-independent control valve shall be used for the control valve.
  - b) Ball valves shall be Belimo, Siemens, or Bray. Ball valves shall be threaded bronze body, chrome plated ball, blowout proof stem, Teflon seat, rated at 600 psi W-O-G working pressure, and 35 psi differential pressure.
  - c) Valves shall not exceed maximum pressure drop of 5 psi. Minimum pressure drop -3 psi or equivalent to the waterside pressure drop of the coil it is associated with, whichever is greater.
  - d) Flow rates for valve sizing shall be based upon the flow rates indicated on the equipment schedules in the drawings.
  - e) Valve sizing shall consider the valve cavitation coefficient. In no case shall a valve be sized so that the pressure drop through the valve causes cavitation with fluid temperatures and pressures encountered in the system during start up or normal operation. If cavitation is possible in a single valve, select two control valves to be piped in series to avoid cavitation.
  - f) Electrical actuated valves shall be provided with Belimo, Bray or Siemens actuators. Actuators shall have current limiting circuitry incorporated in its design to prevent damage to the actuator. A gear release shall be provided on the motor to allow for manual override. Modulating actuators shall be rated for a 4-20 mA input signal. Actuators shall be rated for 24 VAC power. The units shall have visual mechanical position indication showing output shaft and valve position.
3. Glycol run-around loop
- a) Ball valves shall be Belimo, Siemens, or Bray. Ball valves shall be threaded bronze body, chrome plated ball, blowout proof stem, Teflon seat, rated at 600 psi W-O-G working pressure, and 35 psi differential pressure.
  - b) Valves shall not exceed maximum pressure drop of 5 psi. Minimum pressure drop -3 psi or equivalent to the waterside pressure drop of the coil it is associated with, whichever is greater.
  - c) Three-way valve actuators shall be sized to close off tight in both directions against 2.5 times the valve pressure drop at full flow.

- d) Flow rates for valve sizing shall be based upon the flow rates indicated on the equipment schedules in the drawings.
  - e) Valve sizing shall consider the valve cavitation coefficient. In no case shall a valve be sized so that the pressure drop through the valve causes cavitation with fluid temperatures and pressures encountered in the system during start up or normal operation. If cavitation is possible in a single valve, select two control valves to be piped in series to avoid cavitation.
  - f) Electrical actuated valves shall be provided with Belimo, Bray or Siemens actuators. Actuators shall have current limiting circuitry incorporated in its design to prevent damage to the actuator. A gear release shall be provided on the motor to allow for manual override. Modulating actuators shall be rated for a 4-20 mA input signal. Actuators shall be rated for 24 VAC power. The units shall have visual mechanical position indication showing output shaft and valve position.
- D. Control Dampers: Ruskin CD-50 or approved equal.
- 1. Provide dampers with parallel blades for 2- position control.
  - 2. Provide opposed blades for modulating control.
  - 3. Dampers shall be low leakage design with blade and edge seals.
  - 4. Provide multiple sections and operators as required by opening size and sequence of operations, as indicated on the contract drawings.
  - 5. Where indicated on the drawings, or where required for safety, the control damper shall be provided with a damper end switch. End switch will be part of the associated fan safety circuit and shall prevent the fan from engaging/disengaging until the contact is made at the end switch.
- E. Electric Actuators: Johnson Controls, Bray, Belimo, TAC or approved equal. KMC actuators are not approved. Size electric actuators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified. If mixed air AHU has return air, exhaust air and outside air dampers that are not mechanically linked then static safety switch must be installed and wired to safety circuit. Spring return actuators should be provided on heat exchanger control valves or dampers or as specified on the drawings. Control signal shall be 0 to 10 VDC unless otherwise specified on drawings. Actuators with integral damper end switch are acceptable. For VAV reheat valves, actuators shall have a manual override capability to aid in system flushing, startup, and balancing.
- F. Air and Hot Water Electronic Temperature Sensors:
- 1. All electronic temperature sensors shall be compatible with Johnson METASYS systems.
  - 2. Sensors shall be 1,000 ohm platinum, resistance temperature detectors (RTDs) with two wire connections. Duct mounted sensors shall be averaging type. Contractor may install probe type when field conditions prohibit averaging type, but must receive permission from Owner's Representative.
  - 3. Coordinate thermowell manufacturer with RTD manufacturer. Thermowells that are installed by the contractor, but are to have the RTD installed by owner, must be Johnson Controls Inc. series WZ-1000.
- G. Electronic Temperature Sensors and Transmitters:
- 1. Chilled Water and Heating Hot Water, Temperature Sensors
    - a) General: The RTD/Temperature Transmitter/Thermowell assembly shall come as a complete assembly from a single manufacturer. The Assembly shall be suitable for use in the accurate measurement of Chilled/Hot Water temperatures in a mechanical room environment.
    - b) Calibration: Each RTD must be match calibrated to the Transmitter via NIST traceable calibration standards. Results are to be programmed into the transmitter. Results are to be presented on report as after condition at the specified calibration

points. Assembly shall not be approved for installation until Owner has received all factory calibration reports.

- c) RTD:
  - (1) RTD type: 2-wire or 3-wire 100 ohm platinum class A
  - (2) Outside Diameter: 0.25 inch
  - (3) Tolerance: +/- 0.06% Type A
  - (4) Stability: +/- 0.1 % over one year.
  - (5) TCR: 0.00385 (ohm/ohm/°C).
  - (6) RTD shall be tip sensitive.
  - (7) Resistance vs. Temperature table for the RTD must be provided to the Owner.
- d) Transmitter:
  - (1) Transmitter shall be match calibrated to the RTD and assembled as a matched pair.
  - (2) Type: 2 wire (loop powered)
  - (3) Input: 2 or 3 wire 100 ohm platinum class A or class B RTD
  - (4) Output: Output shall be a 4-20 mA signal linear to temperature
  - (5) Calibrated Span:
    - (a) Chilled Water: 30 °F to 130 °F.
    - (b) Hot Water: 100 °F to 250 °F.
  - (6) Calibration Accuracy, including total of all errors, of the Transmitter & RTD matched pair over the entire span shall be within +/- 0.2% of the calibrated span or +/- 0.18 °F, whichever is greater.
  - (7) Supply Voltage: 24 VDC.
  - (8) Ambient Operating Temp.: 32 to 122 °F
  - (9) Epoxy potted for moisture resistance.
  - (10) Mounting: Transmitter shall be mounted in the RTD connection head.
- e) Thermowell
  - (1) Thermowell shall be suitable for immersion in chilled/hot water and steam.
  - (2) Thermowell shall be reduced tip.
  - (3) Thermowell shall be one piece stainless steel machined from solid bar stock.
  - (4) Thermowell shall have 1/2" NPT process connection to pipe thred-o-let.
  - (5) Thermowell Insertion depth shall be ½ the inside pipe diameter but not to exceed 10".
- f) Assembly:
  - (1) Assembly configuration: Spring loaded RTD with thermowell-double ended hex-connection head.
  - (2) Connection head shall be cast aluminum with chain connecting cap to body, have 1/2" NPT process and 3/4" NPT conduit connections, and a sealing gasket between cap and body.
- g) RTD/Temperature Transmitter/Thermowell assembly shall be the following or approved equal:
  - (1) Manufacturer: Pyromation, Inc.
  - (2) Chilled Water: RAF185L-S4C[length code]08-SL-8HN31,TT440-385U-S(30-130)F with calibration SMC(40,60)F
  - (3) Hot Water: RAF185L-S4C[length code]08T2-SL-8HN31,TT440-385U-S(100-250)F with calibration SMC(140,180)F

H. Occupant Override: Provide wall mounted occupant override button in locations shown on drawings.

I. Low Limit Controllers: Provide unit-mounted low limit controllers, of rod-and-tube type, with an adjustable set point and a manual reset. Capillary shall be of adequate length to horizontally traverse face of cooling coil every 12". Multiple low limit controllers may be required for large coils. Controller shall have an extra set of contactors for connection to control panel for alarm status. Locate the thermostat case and bellows where the ambient temperature is always

warmer than the set point.

1. Freeze Stats: Johnson Controls model A70HA-1 or approved equal.
- J. Humidistats: Humidistats must be contamination resistant, capable of  $\pm 2\%$  RH accuracy, have field adjustable calibration and provide a linear proportional signal.
1. HD20K-T91 or equivalent.
- K. Humidity High Limit
1. Multi-function device that can function as a high limit or proportional override humidity controller, as stand-alone proportional controller, or a stand-alone two-position controller.
    - a) Johnson Controls TRUERH HL-67N5-8N00P or approved equal.
- L. Fan/Pump Status: Status points for fan or pump motors with a VFD must be connected to the terminal strip of the VFD for status indication.  
Current switches: Current switches are required for fan and pump statuses that are not connected to a VFD. The switches must have an adjustable trip setpoint with LED indication and be capable of detecting broken belts or couplings. Units shall be powered by monitored line, UL listed and CE certified, and have a five year warranty.
1. Kele, Hawkeye or approved equal.
- M. Relays Used for Fan and Pump Start/Stop: Must have LED indication and be mounted externally of starter enclosure or VFD.
1. Kele, RIBU1C or approved equal.
- N. Power Supply Used to Provide Power to Contractor-Provided Control Devices: Shall have adjustable DC output, screw terminals, overload protection and 24 VAC and 24 VDC output.
1. Kele, DCPA-1.2 or approved equal.
- O. Pressure Differential Switch:
1. Fans: NECC model DP222 or approved equal.
- P. Differential Pressure Transmitter: Provide units with linear analog 4-20mA output proportional to differential pressure, compatible with the Johnson METASYS Systems.
1. Water: Units shall be wet/wet differential pressure capable of a bi-directional pressure range of  $\pm 50$  psid. Accuracy shall be  $\pm 0.25\%$  full scale with a compensated temperature range of 30 to 150 deg F and a maximum working pressure of 250 psig.
  2. Install transmitter in a pre-manufactured assembly with shut off valves, vent valves and a bypass valve.
    - a) Setra model 230 with Kele model 3-VLV, three valve manifold or approved equal.
  3. Air: Units shall be capable of measuring a differential pressure of 0 to 5 in. WC. Accuracy shall be  $\pm 1.0\%$  full scale with a compensated temperature range of 40 to 149 deg F and a maximum working pressure of 250 psig.
    - a) Setra model MRG or approved equal.
    - b) Shall be installed in control panel and piped 2/3 down the duct unless shown otherwise or approved by owners representative.
- Q. Building Static Pressure: Transducer shall utilize a ceramic capacitive sensing element to provide a stable linear output over the specified range of building static pressure. Transducer shall be housed in a wall-mounted enclosure with LCD display. Transducer shall have the following capabilities:
1. Input Power: 24 VAC
  2. Output: 0-10 VDC
  3. Pressure Range: -0.25 to +0.25 inches w.g.
  4. Display: 3-1/2 digit LCD, displaying pressure in inches w.g.
  5. Accuracy:  $\pm 1.0\%$  combined linearity and hysteresis



6. Temperature effect: 0.05% / deg C
  7. Zero drift (1 year): 2.0% max
  8. Zero adjust: Push-button auto-zero and digital input
  9. Operating Environment: 0 to 140 deg F, 90% RH (non-condensing)
  10. Fittings: Brass barbs, 1/8" O.D.
  11. Enclosure: High-impact ABS plastic
  12. Outside Air Sensor Pickup Port: UV stabilized thermoplastic or aluminum "can" enclosure to shield outdoor pressure sensing tube from wind effects. BAPI ZPS-ACC10-rooftop mount, wall mount, or equivalent.
  13. Transducer shall be Veris Industries Model PXPLX01S, equivalent from Setra, or approved equal.
- R. High Static Pressure Limit Switch: Provide pressure high limit switch to open contact in fan circuit to shut down the supply fan when the inlet static pressure rises above the set point. Provide with an adjustable set point, a manual reset button, 2 SPST (normally closed) contacts, and ¼" compression fittings.
1. Kele model AFS-460-DDS, or approved equal.
- S. AIRFLOW/TEMPERATURE MEASUREMENT DEVICES
1. Provide airflow/temperature measurement devices where indicated on the plans. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.
  2. The measurement device shall consist of one or more sensor probe assemblies and a single, remotely mounted, microprocessor-based transmitter. Each sensor probe assembly shall contain one or more independently wired sensor housings. The airflow and temperature readings calculated for each sensor housing shall be equally weighted and averaged by the transmitter prior to output. Pitot tubes and arrays are not acceptable. Vortex shedding flow meters are not acceptable.
  3. All Sensor Probe Assemblies
    - a) Each sensor housing shall be manufactured of a U.L. listed engineered thermoplastic.
    - b) Each sensor housing shall utilize two hermetically sealed, bead-in-glass thermistor probes to determine airflow rate and ambient temperature. Devices that use "chip" or diode case type thermistors are unacceptable. Devices that do not have 2 thermistors in each sensor housing are not acceptable.
    - c) Each sensor housing shall be calibrated at a minimum of 16 airflow rates and have an accuracy of +/-2% of reading over the entire operating airflow range. Each sensor housing shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
      - (1) Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
    - d) The operating temperature range for the sensor probe assembly shall be -20° F to 160 F. The operating humidity range for the sensor probe assembly shall be 0-99% RH (non-condensing).
    - e) Each temperature sensor shall be calibrated at a minimum of 3 temperatures and have an accuracy of +/-0.15° F over the entire operating temperature range. Each temperature sensor shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
    - f) Each sensor probe assembly shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
    - g) Each sensor assembly shall not require matching to the transmitter in the field.

- h) A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location.
- 4. Duct and Plenum Sensor Probe Assemblies
  - a) Sensor housings shall be mounted in an extruded, gold anodized, 6063 aluminum tube probe assembly. Thermistor probes shall be mounted in sensor housings using a waterproof marine grade epoxy resin. All wires within the aluminum tube shall be Kynar coated.
  - b) The number of sensor housings provided for each location shall be as follows:

(1) Area (sq.ft.)	Sensors
<2	4
2 to <4	6
4 to <8	8
8 to <16	12
>=16	16
  - c) Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
    - (1) Insertion mounted through the side or top of the duct.
    - (2) Internally mounted inside the duct or plenum.
    - (3) Standoff mounted inside the plenum.
  - d) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.
- 5. Fan Inlet Sensor Probe Assemblies
  - a) Sensor housings shall be mounted on 304 stainless steel blocks.
  - b) Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
  - c) Mounting feet shall be constructed of 304 stainless steel.
  - d) The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.
- 6. Transmitters
  - a) The transmitter shall have a 16 character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics. Configuration settings and diagnostics shall be accessed through a pushbutton interface on the main circuit board. Airflow shall be field configurable to be displayed as a velocity or a volumetric rate.
  - b) The transmitter shall be capable of independently monitoring and averaging up to 16 individual airflow and temperature readings. The transmitter shall be capable of displaying the airflow and temperature readings of individual sensors on the LCD display.
  - c) The transmitter shall have a power switch and operate on 24 VAC (isolation not required). The transmitter shall use a switching power supply fused and protected from transients and power surges.
  - d) All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
  - e) The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be protected from weather and water.
  - f) The transmitter shall be capable of communicating with the host controls using one of the following interface options:
    - (1) Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire).
    - (2) RS-485: Field selectable BACnet-MS/TP, ModBus-RTU and Johnson Controls N2 Bus.
    - (3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, ModBus-TCP and TCP/IP.
    - (4) LonWorks Free Topology.
  - g) The transmitter shall have an infra-red interface capable of downloading individual sensor airflow and temperature data or uploading transmitter configuration data to

- a handheld PDA (Palm or Microsoft Pocket PC operating systems).
- 7. The measuring device shall be UL listed as an entire assembly.
- 8. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.
- 9. Manufacturer
  - a) Primary flow elements, sensors, meters and transducers shall be EBTRON, Inc. Model GTx116-P and GTx116-F or approved equal.
  - b) The naming of any manufacturer does not automatically constitute acceptance of this standard product nor waive their responsibility to comply totally with all requirements of the proceeding specification.
- T. Electrical Requirements: Provide electric-pneumatic switches, electrical devices, and relays that are UL-listed and of type which meet current and voltage characteristics of the project. All devices shall be of industrial/ commercial grade or better. Residential types will be rejected.
  - 1. EP Switches: Landis & Gyr Powers, Inc. Series 265 - Junction Box Type or approved equal.
  - 2. Relays: Relays shall have an LED status indicator, voltage transient suppression, Closed-Open-Auto switch, plastic enclosure, and color coded wires. Kele model RIBU1C or approved equal.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION OF CONTROL SYSTEMS**

- A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
- B. Control Air Piping:
  - 1. All control air piping shall be copper. Exception: Flexible Tubing may be used for a maximum of two (2) feet at connections to equipment [except for steam control valves] and inside control cabinets.
  - 2. Provide copper tubing with a maximum unsupported length of 3'-0".
  - 3. Pressure Test control air piping at 30 psi for 24 hours. Test fails if more than 5 PSI loss occurs.
  - 4. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support tubing neatly.
  - 5. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system.
  - 6. All control tubing at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel.
  - 7. Provide pressure gages on each output device.
  - 8. Paint all exposed control tubing to match existing.
- C. Raceway: Raceway is to be installed in accordance with the National Electric Code. Use of flexible metal conduit or liquidtight flexible conduit is limited to 36" to connect from EMT to devices subject to movement. Flexible raceway is not to be used to compensate for misalignment of raceway during installation.
- D. Control Wiring: Install control wiring in raceway, without splices between terminal points, color-coded. Install in a neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code.
  - 1. Install circuits over 25-volt with color-coded No. 12 stranded wire.
  - 2. Install electronic circuits and circuits under 25-volts with color-coded No. 18 stranded

- twisted shielded pair type conductor.
3. N2 communications bus wire shall be 18 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, described as 18-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent.
    - a) Metastat wiring shall be minimum 20 AWG, plenum rated, stranded, 8 conductor stranded wire.
  4. FC communications bus wire shall be 22 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, described as 22-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent.
    - a) Network sensor wiring (SA Bus) shall be 22 gauge plenum rated stranded twisted wire, 4 conductor.
  5. All control wiring at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel. Label all control wires per bid documents.
- E. All low voltage electrical wiring shall be run as follows:
1. Route electrical wiring in concealed spaces and mechanical rooms whenever possible.
  2. Provide EMT conduit and fittings in mechanical rooms and where indicated on drawings.
  3. Low voltage electrical wiring routed above acoustical ceiling is not required to be in conduit, but wire must be plenum rated and properly supported to building structure.
  4. Provide surface raceway, fittings and boxes in finished areas where wiring cannot be run in concealed spaces. Route on ceiling or along walls as close to ceiling as possible. Run raceway parallel to walls. Diagonal runs are not permitted. Paint raceway and fittings to match existing conditions. Patch/repair/paint any exposed wall penetrations to match existing conditions.
- F. All devices shall be mounted appropriately for the intended service and location.
1. Adjustable thermostats shall be provided with base and covers in occupied areas and mounted 48" above finished floor to the top of the device. Tubing and/or wiring shall be concealed within the wall up to the ceiling where ever possible. Surface raceway may only be used with approval of Owners Representative. Wall mounted sensors such as CO2, RH, and non-adjustable temperature sensors shall be mounted 54" above finished floor. Duct mounted sensors shall be provided with mounting brackets to accommodate insulation. Mounting clips for capillary tubes for averaging sensors are required.
  2. All control devices shall be tagged and labeled for future identification and servicing of control system.
  3. Preheat and mixed air discharge sensors must be of adequate length and installed with capillary tube horizontally traversing face of coil, covering entire coil every 24 inches bottom to top.
  4. All other air sensors located in AHU's shall be of adequate length to cover every 36" of the air flow path.
  5. All field devices must be accessible or access panels must be installed.
- G. Install magnehelic pressure gage across each air handling unit filter bank. If the air handling unit has a prefilter and a final filter, two magnehelic pressure gages are required.

### 3.02 ADJUSTING AND START-UP

- H. Start-Up: Temporary control of Air Handling Units shall be allowed only if approved by the owner's representative to protect finishes, etc., AHUs may be run using caution with temporary controls installed by contractor early in the startup process. All safeties including a smoke detector for shut down must be operational. Some means of discharge air control shall be utilized and provided by the contractor such as a temporary temperature sensor and controller located and installed by the Contractor.
- I. The start-up, testing, and adjusting of pneumatic and digital control systems will be conducted by owner. Once all items are completed by the Contractor for each system, Contractor shall allow time in the construction schedule for owner to complete commissioning of controls

before project substantial completion. This task should be included in the original schedule and updated to include the allotted time necessary to complete it. As a minimum, the following items are required to be completed by the Contractor for Owner to begin controls commissioning.

1. Process Control Network
  - a) The control boards and enclosures need to be installed in the mechanical rooms.
  - b) The fiber optic conduit and box for the process control network needs to be installed. Once in place, Owner needs to be contacted so the length of the owner provided fiber cable can be determined and ordered, if required. Coordinate with Owner to schedule the pull in and termination of the fiber cable. Power should be in place at that time. (Fiber for the process control network is required to allow metering of utilities prior to turn on.)
2. Heating System
  - a) Pumps, heat exchangers, steam pressure reducing station, piping, control valves, steam and/or hot water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, steam regulators set to required pressure, condensate pumps operational, heating system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.
3. Cooling System
  - a) Pumps, heat exchangers, piping, control valves, chilled water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, cooling system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.
4. Air Handlers
  - a) Prior to owner commissioning, at a minimum, the following items shall be complete: Power wiring, motor rotation check, fire/smoke dampers open, control wiring including all safeties, IO cabinet, air handler cleaned, and filters installed as required. To protect the systems from dirt, outside air with no return will be used until the building is clean enough for return air operation.
5. Exhaust and Energy Recovery Systems
  - a) Exhaust fans need to be operational and under control before labs can be commissioned.
6. Some balance work can be done alongside the control work as long as areas are mostly complete and all diffusers are in place.

### 3.03 CLOSEOUT PROCEDURES

- J. Contractor shall provide complete diagrams of the control system including flow diagrams with each control device labeled, a diagram showing the termination connections, and an explanation of the control sequence. The diagram and sequence shall be framed and protected by glass and mounted next to controller.
- K. Contractor shall provide as built diagram of network bus routing listing all devices on bus, once wiring is complete prior to scope completion.

**END OF SECTION**

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## **24 00 00 AIR DISTRIBUTION**

### 24 00 01 GENERAL

1. This Section specifies air distribution systems.
2. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Divisions 20 - 29 of the Specifications.
3. Provisions and conditions cited in this Section shall apply to Work for other sections of Divisions 20 - 29 of these Specifications.

### 24 00 02 REFERENCES, REGULATORY REQUIREMENTS:

- A. Work for this section of the specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20 in addition to the following:
1. ASHRAE, "Handbook 1997 Fundamentals"; Chapter 32 - Duct Design.
  2. ASHRAE, "Handbook 1996 Equipment"; Chapter 16 - Duct Construction.
  3. ASTM A90-81 (1991), "Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles".
  4. ASTM A525-91b, "Spec for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process".
  5. ASTM A527/A527M-90, "Spec for Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality".
  6. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
  7. SMACNA "HVAC Duct Construction Standard – Metal and Flexible" – Second Edition.
  8. UL 33, "Heat Responsive Links for Fire Protection Service."
  9. UL 555, "Fire Dampers and Ceiling Dampers."
  10. UL 181, "Factory Made Air Ducts and Connectors."

### 24 00 03 REFERENCES, RELATED SECTIONS OF THE SPECIFICATIONS

Requirements of the following Sections of the Specifications apply to Work for this Section:

- A. Division 20 - Basic Mechanical Conditions and Basic Mechanical Materials & Methods
- B. Division 23 – HVAC Piping and Equipment and Temperature Controls

### 24 00 04 DEFINITIONS

- A. The size of the ducts shown on the drawings and in this Section of the Specifications shall be the outside dimension of the ductwork which will take into account any internal acoustical lining thickness specified for duct system or sub-system.
- B. The term **"supply air"** where used in this Section of the Specifications shall mean downstream of a coil.
- C. The term **"outdoor air"** where used in this Section of the Specifications shall mean ambient air that has not been conditioned.

- D. The term **“return air”** where used in this Section of the Specifications shall mean conditioned air that is returned from the space.
- E. The term **“mixed air”** where used in this Section of the Specifications shall mean air streams that are a mixture of **“outdoor air”** and **“return air”**.
- F. The term **“relief air”** where used in this Section of the Specifications shall mean excess return air that relieved from the building.
- G. The term **“exhaust air”** where used in this Section of the Specifications shall mean air that is removed due to contaminates, odors, or heat.

24 00 05 WORK INCLUDED

Furnish material, labor and services necessary for and incidental to the installation of the following systems where shown on the Plans and as hereinafter specified. Include all necessary considerations in the related sections of the Specifications (Sub-section 20 30 03) to perform the Work completely.

- A. Sheet metal ducts, sheet metal plenums, duct linings, flexible ductwork, dampers and accessories.
- B. Louvers, louvered penthouses, intake/relief hoods.
- C. Installing accessories specified in referenced sections above.
- D. Smoke stopping of all penetrations of ductwork, and firestopping of the same through fire rated partitions as shown on the Architectural drawings including, but not limited to stairways, shafts, corridors, floors, roofs, and required exits (Refer to Section 20 10 20).
- E. Contractor shall coordinate his work with the work of other trades, and with the architectural and structural drawings.

24 00 06 SUBMITTALS

- A. The Contractor shall submit the following for approval in accordance with Subsection 20 00 43, Duties of Contractor - Submittals.
- B. Submittals shall include drawings showing joining methods, location of duct transverse joints, and duct support locations.
- C. Submittals shall be required for all shop fabricated balancing dampers.
- D. At the completion of the project, submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all piping and duct penetrations are smoke or fire stopped as required by the Code.

24 00 07 SPECIAL REQUIREMENTS

- A. Contractor shall inspect each component of the heating and air conditioning system to eliminate rattles, air whistles, vibration, and mechanical system sound transmission. Rough edges in ducts, insecure dampers, turning vanes, fire dampers, etc., shall be corrected to assure no recurrence of the noise source. Each vibration isolator and flexible connector shall be adjusted to limit transmission of sound to the occupied space.
- B. Where Ductwork and accessories installed under this section of the specification tie-in to existing systems, Contractor shall verify existing for: sizes, direction of flow (via pressure or



physical tracing of ductwork, not labels), materials, and elevations before installing new work. Contractor shall notify Architect/Engineer upon discovery of discrepancy. Work performed prior to verification will be corrected at no cost to Owner.

#### 24 00 08 AIR DISTRIBUTION CLEANLINESS

- A. Contractor shall implement procedures to maintain an "Advanced Level" of ductwork cleanliness per the latest addition of the SMACNA Duct Cleanliness for New Construction Guidelines.
1. Production and Site Delivery:
    - a. Self-adhesive labels for part of identification are to be applied to the external surfaces only.
    - b. During transportation, ductwork and air distribution components shall be sealed either by blanketing or capping the duct ends, bagging small fittings, surface wrapping or shrink wrapping.
  2. Site Storage:
    - a. Temporary storage shall be located away from high dust generating processes such as masonry, tile cutters, saws, drywall sanding, mortar and plaster mixers, roof pitch kettles, portable electric generators, and main walkways that will be constantly broom swept.
    - b. Temporary storage shall include pallets or blocking to keep ductwork and air distribution components above floor surface to prevent water damage.
    - c. Coverage should be used to protect stored materials at all times.
    - d. Duct open ends and air side of air distribution components shall be securely sealed at all times.
    - e. Seals shall be visually examined and if damaged, resealed with an appropriate material.
  3. Installation:
    - a. Before installation of individual duct sections and air distribution components, they are to be inspected to ensure that they are free from debris and shall be wiped clean if debris exists.
    - b. The working area shall be clean, dry, and the airside of ductwork and air distribution components protected from dust and moisture.
    - c. Protective coverings shall only be removed immediately before installation and inspected to determine if additional wipe down is necessary.
    - d. Open ends on completed ductwork shall be sealed immediately if left for an extended period of time (work breaks, overnight, etc.).

#### **24 31 00 SHEETMETAL DUCTWORK**

##### 24 31 01 MATERIAL

- A. All ducts unless specified otherwise shall be constructed from sheets or rolls of G-90 or better-galvanized steel, LFQ, Chemtreat. Fiberglass ductboard is prohibited.
- B. All new supply, return, and exhaust ductwork serving the natatoriums shall be constructed from 3003-H14 Series aluminum. All new outdoor air ductwork and plenums shall be the same.

- B. All supply ductwork, unless specified otherwise, shall be constructed of gauges and reinforcement to 4" w.g. static pressure in SMACNA Duct Construction Standard – Latest Edition.
- C. All return, exhaust, outdoor air, relief, and supply ductwork downstream of terminal units shall be constructed of gauges and reinforcement to 2" w.g. static pressure in SMACNA Duct Construction Standard – Latest Edition. Panels in all ducts 12" and larger shall be cross-broken or beaded on 12" centers.
- D. Where local code requires gauges heavier than required by SMACNA then the local code shall govern.
- E. Round ductwork where scheduled, or indicated on the plans shall be K-27 double wall internally insulated for sound control and/or thermal performance. All diameters and dimensions shown on the plans are the outside (pressure shell) dimension of the duct. Fitting shall also be double wall, tack welded, and sealed. Duct and fittings shall be labeled on the inside to reduce preparation for painting. Duct manufactured by McGill Airflow, Eastern Sheet Metal, United Sheet Metal, or equivalent.
  - Pressure shell: Spiral lockseam, 3003-H4 Aluminum
  - Insulation: 2" thick, 1 pound per cubic foot density, duct liner.
  - Inner Liner: Spiral lockseam, Solid 3003-H4 Aluminum

#### 24 31 02 CONSTRUCTION

- A. All ductwork shall be neatly constructed, stiffened, on the outside surfaces where necessary to prevent perceptible vibration or buckling. All ducts, housings, etc., shall be fabricated as detailed on the drawings and in the SMACNA Duct Construction Manual – Latest Edition.
- B. All rectangular ducts unless specified otherwise shall be "Pittsburgh Lock" longitudinal joints. Snaplock is not acceptable.
- C. All round ducts and flat oval ducts shall have spiral seams or continuously welded longitudinal seams.
- D. All transverse joints in rectangular ductwork 24" and larger shall be Ductmate, SMACNA T-25, or approved equivalent. All flanged ductwork, regardless of pressure class, shall use gaskets, corner closures, and be TEK screwed or riveted on 10" centers with a minimum of two (2) per side. Transverse joints in rectangular ductwork smaller than 24" shall be made in accordance with SMACNA suitable with the pressure class.
- E. All transverse joints in round and oval ductwork 24" and larger shall be Ductmate, or approved equivalent. Transverse joints in round and overall ductwork smaller than 24" shall be beaded sleeve joints.
- F. Ducts shall be securely supported in accordance with SMACNA Duct Construction Manual – Latest Edition and in no case less than double thickness 1" x #24 gauge galvanized metal. Cable hangers are not allowed.
- G. Ducts that are to be externally insulated shall not be supported on unistrut channel unless it required based upon loading. Hanger rods for trapeze bars shall be spaced to allow for insulation installation.

24 31 03 SEALING

- A. Duct sealant shall be flexible, water-based, adhesive sealant designed for use in 4" static pressure systems. Sealer shall be compatible with chlorine-laden air streams. Sealer shall be UL listed and conform to ASTM E84. Sealer shall be equal to Ductmate PROseal, United McGill Uni-Mastic, Duro-Dyne DSW, or equivalent.
- B. All supply ductwork unless specified otherwise shall be SMACNA's seal class A.
- C. All return, exhaust, outdoor air, relief and supply ductwork downstream of terminal units shall be SMACNA's seal class B.

24 31 04 DUCTWORK LEAKAGE TESTING

- A. Installed ductwork on systems greater than 5HP shall be tested prior to installation of access door, take-offs, or other specialties.
- B. A testing shall be scheduled for witness per the general conditions.
- C. The supply trunk duct for each system shall be tested in whole or up to 100' in length whichever is lesser.
- D. The return trunk duct for each system shall be tested from 50' upstream of the fan inlet to the unit plenum box.
- E. Exhaust ductwork for each fan shall be tested from 50' upstream of the fan inlet to the point of discharge.
- F. Outdoor air and relief air ducts for each fan system shall be tested in whole.
- G. Ductwork shall be tested as follows:
  - 1. Ductwork shall be tested in accordance with SMACNA HVAC Air Duct Leakage Test Manual.
  - 2. Use a certified orifice tube for measuring the leakage.
  - 3. Define section of system to be tested and blank off.
  - 4. Determine the design airflow for the portion of the duct to be tested.
  - 5. Determine the allowable leakage (cfm) for the section being tested.
  - 6. Pressurize to operating pressure and repair any significant or audible leaks.
  - 7. Repressurize and measure leakage.
  - 8. Repeat steps 6. and 7. until the leakage measured is less than the allowable defined in step 5.
- H. The following Leak Class and Duct Pressure Class shall be used to determine the Leakage Factor in cfm/100 S.F. Duct. Ducts shall be tested at the design pressure class. Max. leakage = Leak Class x (design pressure)<sup>0.65</sup>
  - 1. 

<u>Rectangular Duct Pressure Class</u>	<u>Leak Class</u>
All	6

(i.e. 4" duct systems shall be tested at 4" and the leakage shall not exceed 14.8 cfm/100 S.F. duct and 2" duct systems shall be tested at 2" and the leakage shall not exceed 9.4 cfm/100 S.F. duct).
  - 2. 

<u>Round Duct Pressure Class</u>	<u>Leak Class</u>
----------------------------------	-------------------

All 3  
(i.e. 4" duct systems shall be tested at 4" and the leakage shall not exceed 7.4 cfm/100 S.F. duct and 2" duct systems shall be tested at 2" and the leakage shall not exceed 4.7 cfm/100 S.F. duct).

24 31 05 FITTINGS

- A. Rectangular duct branch take-offs, or rectangular to round, shall be 45°-boot fittings, spin in fittings are not acceptable.
- B. Rectangular duct proportional splits shall be made the sizes as shown on the drawings. Where duct sizes are changed from the original design, Contractor shall proportion split equal to the split in airflow.
- B. Rectangular duct changes in direction:
  - 1. 90 degree elbows, refer to plans, shall be mitered with turning vanes; or radiused with centerline radius to width ratio of 0.75 (inside radius/width ratio 0.25 with curve ratio 0.585) with 2 splitter vanes.
  - 2. 45 degree and less elbows shall be mitered without vanes.
  - 3. Elbows other than above shall be radiused with centerline radius to width ratio of 1 without splitter vanes.
- C. Round or Oval elbows and changes in direction shall have a minimum centerline radius of 1-1/2 that of duct size. Round or oval branch take-off shall be 45 degree booted style similar to McGill Airflow Lo-Loss Tee.
- D. When approved by the Engineer ducts may be notched at structural steel. The converging angle shall be no greater than 30°, the diverging angle shall be no greater than 15°.
- E. When approved by the Engineer objects may penetrate a duct. An airfoil shape shall be placed around the object to minimize turbulence.

24 31 06 PLENUMS

- A. Sheetmetal plenums shall be constructed of a minimum of 18 ga. or greater as determined by the pressure class of the plenum. Sheetmetal and shall be braced and reinforced to support the weight of a 200-lb. person. Tie rods shall not be used.
- B. Plenums shall be constructed without air turning vanes.
- C. Plenums shall have access doors as sized on drawings, where no size is shown provide a minimum size of 18" x 36".

24 31 07 PRE-FABRICATED INTAKE/RELIEF AIR ROOFTOP PLENUM BOXES

- A. Provide Trane custom plenum box or approved equal. Plenum box to incorporate heat recovery coils as described on the drawings and in Section 23 82 01.
- B. Refer to the plenum box dimensions on the mechanical drawings. Construction of the plenum box to be 4" double wall foam R-25 with thermal break.
- C. Interior/Exterior panel material to be aluminum along with 16 ga. aluminum double panel floor.
- D. Provide with 6" structural aluminum base frame.

- E. Unit air leakage shall not exceed 0.5% of design cfm at +12.0" w.g. in all positive-pressure sections and 12.0" w.g. in all negative-pressure sections. Leakage shall be calculated by totaling all leakage either in to or out of the unit.
- F. Casing deflection shall not exceed L/250 at +12.0" w.g. in all positive-pressure sections and 12.0" w.g. in all negative-pressure sections.
- G. A thermal break shall be provided throughout the entire base and floor assembly that ensures no member on the exterior of the unit, including fasteners, has through metal contact with any member on the interior of the unit, including fasteners.
- H. Plenum boxes shall have bottom opening for relief and outside air duct. Refer to the mechanical drawings for duct opening size and location.
- I. Relief air plenum box: Provide with energy heat recovery 30% glycol coil. Coil casings shall be copper. Coils shall be constructed with no less than 5/8" diameter x .025" wall thickness copper tubes and .006" thick copper fins spaced not closer than indicated on equipment schedule. The number of rows shall not be less than scheduled on the equipment schedule. Coil construction of dissimilar metals shall not be acceptable.
- J. Outside air plenum box: Provide with energy heat recovery 30% glycol coil. Coil casings shall be galvanized. Coils shall be constructed with no less than 5/8" diameter x .025" wall thickness copper tubes and .006" thick aluminum fins spaced not closer than indicated on equipment schedule. The number of rows shall not be less than scheduled on the equipment schedule.
- K. Coils connections shall be NPT red-brass for relief plenum box and black steel for outside air plenum box. Pipe chase location shall be coordinated during submittal process and pipe connections shall be inside the plenum box. No exterior pipe connections shall be allowed.
- L. Condensate drain pans shall be installed with 2" of insulation provided between the drain pan and the casing; units with multiple vertically stacked coils shall have an intermediate drain pan. The pans shall be of continuously welded seams, Series 300 stainless steel construction, 'V' shaped and/or sloping to the drain connection, flat pans will not be acceptable. Drain pans shall be located in the heat recovery glycol coil section.
- M. Coils performance shall be AHRI 410 certified. Submittals shall include AHRI certified reference number. Coils shall be tested for 250 psig under water and shall be guaranteed for 200 psig working pressure.
- N. Provide with double wall construction access door. Refer to the mechanical drawings for dimensions and location.
- O. Provide with light and switch. Light switch outlet shall be provided with GFCI outlet and location next to access door.
- P. Provide with (2) side duct openings with control dampers on the relief air plenum box, Ruskin model CD-50 (aluminum, airfoil, opposed blade). Size the control dampers for 8,000 CFM each for PAU-1 relief air plenum box and size for 16,000 CFM each for PAU-2&3 relief air plenum box. Refer to the mechanical drawings for duct opening sizes and location. Modulating actuator for control damper to be provided by controls contractor.
- Q. Outside air plenum box shall come with wind driven rain resistant stationary louver (Ruskin model EME3625) and Ruskin CD-50 (aluminum, airfoil, parallel blade) control damper. Two position actuator for control damper to be provided by controls contractor. Louver shall come

with aluminum bird screen in removable frame. Louver/control damper sizing shall not exceed the pressure drop of the 0.25".

- R. Unit shall come with filter rack and filters. There shall be magnhelic gauge per bank of filters. Refer to the filter specification section and schedule on the mechanical drawings for additional details.
- S. Provide aluminum safety grating for walking on surface over duct opening. Coordinate the actual size prior to purchase. Safety grates shall support a minimum of 300-pound load. Grates to be removable for maintenance.
- T. Under outdoor ambient temperature of 0°F and conditions on the interior of the unit of 82°F dry bulb and 71°F wet bulb, condensation shall not form on the casing. Manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, Manufacturer shall provide, in writing, a guarantee against condensation forming on the unit exterior under the scheduled supply air temperature and design conditions on the exterior of the unit of X°F dry Y°F wet bulb. The guarantee shall note that the Manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. Copies of the guarantee shall be provided to the Engineer and the Owner.

#### 24 31 08 AIR THERMOMETERS

- A. **Air thermometers shall be provided and in the supply air, coil discharge of all air handling unit coils, return air, mixed air, and outside air of the air handling units.**
- B. Airstream thermometers shall be bimetal type, with an accuracy of  $\pm 1^\circ\text{F}$  throughout the range with 5" dial size, 12" stem length,  $\frac{1}{2}$ " N.P.T. back side connector with plain slip ring case of 304 stainless steel, and recalibrator. Thermometer shall be Trerice Model No. B85212 or approved equal as manufactured by Weksler, Marsh, or Marshalltown Instruments. Thermometers for use in the mixed air shall have flexible averaging elements strung with the mixed air temperature sensor and freezestat sensor elements. Mixed air thermometers shall be Trerice No. V80445 with bulb number 4-3-1.
- C. Range shall be as follows:

Outdoor air	-40-160°F
Mixed air	0-100°F
Supply air	25-125°F
Return air	25-125°F
Preheat coil discharge	25-125°F
Reheat coil discharge	25-125°F
Chilled water coil discharge	25-125°F

#### **24 33 00 AIR DISTRIBUTION ACCESSORIES**

##### 24 33 01 BALANCING DAMPER

- A. Furnish and install volume dampers at each main branch take-off and in such other locations where required to properly balance the air distribution systems.
- B. All dampers, except those located downstream from terminal units used to adjust individual grilles, shall have frames and bearings and shall have quadrant lock regulators with thread screw to allow damper to be securely locked into place.

- C. Balancing dampers downstream from terminal units that are contractor fabricated or apart of manufactured branch fitting shall be a minimum of 18-ga. plate, 3/8" continuous shaft with locking quadrant handle equal to Duro Dyne model Quadline.
- D. Rectangular dampers up to size 24" x 12" shall be Ruskin MD25, Nailor 1870, Arrow, Air Balance, NCA, or shop fabricated equal, approved by the Engineer.
- E. Round dampers up to size 20" diameter shall be Ruskin MDRS25, Nailor 1890, Arrow, Air Balance, NCA or shop fabricated equal, approved by the Engineer.
- E. Rectangular dampers larger than 24" x 12" shall be Ruskin MD35, Nailor 1820 or equivalent manufactured damper by NCA.
- G. Where volume dampers are to be adjusted through walls or ceilings, such dampers shall be operated by regulators designed for recessed installation and provided with a cover plate which shall be flush to the surface of the wall or ceiling. Concealed regulators, as manufactured by Duro Dyne Corporation or Elgen shall be of the indicator type. Regulator shall be provided with a spring washer for non-binding adjustment and hex lock nut in addition to wedge pin which shall be installed to prevent damper rattle. Cast alloy regulator housing, with "open to shut" range positioning markers, shall be secured with removable cover to expose regulator for adjustments.
- H. All automatic dampers and control dampers shall be as specified in "Temperature Control". Dampers shall be installed under Division 23 30 00.
- I. Control Damper Installation
  - 1. Dampers installed in walls shall be installed with wall sleeves to allow direct coupled actuator installation.
  - 2. Large damper installations with multiple actuators shall be installed with 8" sheetmetal blank-off/spacers between them to allow direct coupled actuator installation. Provide structural supports as required for a straight, true, level and square installation.
  - 3. Dampers shall be attached with fasteners on 6" centers with a minimum of 2 per side.

24 33 02 AIR TURNING VANES

- A. Furnish and install directional air turning vanes in ductwork at all 90 degree mitered elbows and 90 degree radiused elbows.
- B. Mitered 90 degree elbows vanes shall be:
  - 1. Single rolled type with a radius of 2" with 1.5" spacing.
  - 2. Single rolled type with a radius of 4-1/2" with 3.25" spacing.
  - 3. Double thickness type with a radius of 4-1/2" with 3.25" spacing. Double thickness 2" radius is not allowed.
  - 4. Tie rods shall be used to limit the maximum unsupported width per the type of vane used per SMACNA.
  - 5. Vanes shall be solidly installed and rattle-free locked into each slot of preformed vane guide rails as manufactured by Duro Dyne Corporation or Elgen. Rails shall be constructed of 24 gauge galvanized steel, specially embossed for extra strength and sturdiness.
- C. Radiused 90 degree elbows shall have 2 vanes. Vanes shall be single thickness, Splitter Vanes for radius elbows shall be fabricated based on the "SMACNA HVAC Systems Duct Design Manual" using the appropriate curve ratio.

### 24 33 03 FLEXIBLE CONNECTORS

- A. Furnish and install flexible connections at the connections to air handling equipment as indicated on the plans. Flexible connections shall be U.L. listed fabric that meets NFPA 90A. It shall weigh not less than 24 oz per sq. yd, have a tensile strength of not less than 500 psi, and shall be chemical compatible with chlorine-laden air streams. Flexible connections shall be preassembled "Super Metal-Fab" with 6" fabric attached to 3" metal on either side by means of "Grip-Loc" seam. At least one inch of slack shall be allowed when making connection to insure that no vibration is transmitted from fan to ductwork. The flexible connectors shall be fastened to ductwork and equipment by screws, rivets or spot welding. Flexible connectors shall be No. MF6N as manufactured by Duro Dyne Corporation, or equivalent by Vent-Fabrics or Elgen.

### 24 33 04 ACCESS DOORS AND PANELS

- A. Access panels shall be provided at all duct mounted automatic control dampers, fire dampers, and as shown on drawings.
- 2" Pressure Class: Door shall be SMACNA Standard, 12" x 12", double skin, 1" fiberglass insulation, with underside duct to frame gasket for reduced leakage.  
  
With window Ruskin ADHW22, or equivalent.
  - 4" and Higher Pressure Class: Oval shape, ultra low leakage at 8" w.c.  
  
With window Ductmate Observation Access Door.
- B. Access doors in casings and housings shall be fabricated double skin doors with 1" thick insulation between inner and outer surface as detailed in the SMACNA Duct Manual. Provide two compression latches equal to Ventlok #260 on each door. Where access doors provide for personnel entry into the system, they must be provided with inside/outside latch hardware. Provide access doors at all locations indicated on the drawings and into the mixing chamber of all air handling units. Size shall be 18 x 36, unless indicated otherwise on the drawings. Ruskin GPAD or equivalent.
- C. For access panels required in ceiling, walls, etc. of the building construction, see Section 20 10 10.

### **24 34 00 FANS**

- A. General
- B. All fans shall be licensed to bear the AMCA Performance Air and Sound Certified Ratings Seal. Fan air performance ratings shall be based on test conducted in an AMCA registered laboratory in accordance with AMCA 210 Air Performance Testing and AMCA 300 Sound Performance Testing. Fan curve families (tables will not be accepted) and octave band sound data shall be furnished with submittal data.
- C. All fans shall have premium efficiency open dripproof motor unless indicated otherwise. Fans with variable speed drives shall have inverter duty motors. All fans with V-belt drives shall be equipped with adjustable pitch sheave rated for 1.5 times the motor horsepower, shall have sliderail base, and shall have a belt-guard.



- D. All fan shafts shall be designed so that the first critical speed is at least 20% over the maximum operating speed. Bearings shall be self-aligning, grease lubricated, anti-friction, pillow block bearings with a minimum life (L50) of 200,000 hours.
- E. Where fans are other than scheduled the following criteria shall apply: Fans shall be picked at the scheduled flow and static pressure, fan efficiency shall not be more than 5% less efficiency than scheduled fan, fan motor shall not be larger than scheduled motor (manufacturer shall notify Contractor of any larger motor sizes, Contractor can pursue equipment substitution as required in subsection 20 00 52), the fan rpm shall not be within 15% of the maximum or minimum allowable rpm, and in general the fan selections shall be based upon maximum energy efficiency but in no case shall the fan wheel be smaller than what is scheduled. Where selection point is within 15% of the maximum allowable rpm of the fan class, provide a higher fan class.
- F. Where Roof curbs for exhaust fans are required, roof curbs shall be constructed of galvanized steel. Curbs are to be internally insulated and fully gasketed between the curb top and fan base with the curb providing full perimeter support and air seal for the unit. The finished height of the roof curb shall be 10" – 12" above the finished roof unless a greater height is required as scheduled or noted on the drawings. The Contractors shall coordinate the curbs with the roof insulation thickness.

#### 24 34 01 UTILITY FAN

- A. Utility fans shall be heavy duty class II, welded steel scroll construction, airfoil wheel type, welded blades, steel shaft and removable guard assembly over the motor. Fans shall have inlet and outlet connection for external ductwork to connect. Provide drain openings at the bottom of each fan scroll. Provide with arrangement 4 direct drive motor suitable for outdoor installation. Fan disconnects and VFD will be provided by others. Fan airflow surfaces to be coated with epoxy paint or similar with equal resistance to chlorine based corrosion. Fan shall be tested for vibration isolation prior to shipment. Refer to the mechanical drawings for additional information on fan performance, discharge arrangement, fan accessories, quantity, etc. Each fan shall be given an electronic vibration analysis in accordance with ANSI/AMCA Standard 204, while operating at the specified fan RPM. The vibration signatures shall be taken on the motor mounting plate in the horizontal, vertical and axial direction. The maximum allowable fan vibration shall be 0.08 in. /sec peak velocity – arrg. 4, filter-in as measured at the fan RPM. Report shall be provided at no charge to the customer upon request.. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration. Bearings that use set screws shall not be allowed and shall have Zerk fittings to allow for lubrication.
- B. Fans shall be Greenheck USF or approved equal.

#### **24 41 00 FILTER ASSEMBLIES**

- A. Furnish and install for outside air, return air, and relief air systems, filters and front-loading filter housings of the types, quantity, and arrangement scheduled (or otherwise indicated on the plans).

#### 24 41 01 FILTER HOUSING

- A. Housing shall be a complete factory assembled housing with upstream and downstream outwardly turned flanges for insertion into the ductwork/air handling unit system. The housing

shall be manufactured of a minimum of 16 ga. Welded galvanized steel with associated clips required to hold filter cells. Filters shall be front (upstream of airflow) loading. Continuous closed cell neoprene gasketing on the perimeter shall be provided at both ends of the housing. These channels shall incorporate a positive-sealing gasket material to seal the top and bottom of the filter cartridge frames to prevent bypass. The frame shall be assembled from two corner sections and welded to assure a rigid and durable frame assembly. Filter banks shall be reinforced with vertical stiffeners to assure rigidity. Frame shall include filter centering dimples on each frame wall to facilitate ease of filter installation and assure filter centering against filter sealing flange. Leakage shall be prevented between frames by factory installed gasketing. Filter frames shall be capable of being loaded or unloaded through front loaded access. Refer to the mechanical drawings for combinations of filters frame (2"+12" deep filters) within outside air duct. Filters shall be accessible from front loading.

- B. Housing frame shall be Camfil Type 8 or approved equal.

#### 24 41 02 FILTERS

- A. 2" filters shall be dust spot efficiency on ASHRAE Test Standard 52.1 and MERV 8 on ASHRAE Test Standard 52.2. The filter media shall be a self-extinguishing, non-woven cotton and synthetic fabric, UL Class 2. The enclosing frame shall be a rigid, heavy duty, moisture resistant, high wet strength beverage board die cut for dimensional accuracy with diagonal support members. The pleated media pack shall be bonded to the inside of the frame on all four edges to prevent leakage. The media support shall be a welded wire grid bonded to the filter media to reduce media oscillation. The media support shall be contoured shape allowing total use of the filter media for longer life.
1. 2" filters shall not have less than 14 pleats per linear foot and not less than 17 square feet of effective media (based on 24" x 24"). Filters shall be as manufactured by Camfil-Farr Filter model 30/30, American Air Filter model 300X, or approved equivalent.
- B. Second stage filters shall be high-efficiency pleat-in-pleat V-bank disposable type. Filter media shall be microfine glass formed into uniformly spaced pleats separated by fiberglass thread separators and formed into a minipleat pack design. Each minipleat pack shall be assembled into a V-bank configuration. Filter shall be rated as UL Class 900.
1. 12" deep 90% dust spot efficiency on ASHRAE Test Standard 52.1 and MERV 13 on ASHRAE Test Standard 52.2. Filters shall have not less than 200 square feet of effective media based on 24" x 24". Filters shall be as manufactured by Camfil-Farr model Durafil ES, or approved equivalent.
- C. Each filter assembly shall have a gauge arranged to measure pressure across each filter type in housings containing more than one filter. For multiple filter banks in series (i.e. 2" + 12" filters), provide a gauge for each bank of filters. Provide all necessary pressure taps, tubing, fittings, valves, and mounting hardware. Gauges shall be Dwyer Model 2001 or equivalent (0-1" range for single stage 30% filters) (0-2" range for 65% or greater filters or multiple stages). Each filter assembly shall have an engraved plastic plate indicating what the final change-out pressure is for each type of filter.
- D. Refer to mechanical drawings for additional information on filter schedule, location, quantity, sizes, etc.

END OF SECTION  
071588.002

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## **26 00 00 ELECTRICAL**

### 26 00 01 GENERAL

- A. The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Division 26 of the Specifications.
- B. Provisions and conditions cited in this Section shall apply to Work for other sections of Division 26 of these Specifications.
- C. The organization of the Specifications into Divisions, Sections and Subsections, and the arrangement of the Plans shall not in and of itself divide the Work among the Contractors and Subcontractors nor establish the Work to be performed by any trade. The "Scope of Work" and "Work Included" under each respective sectional heading, nevertheless, attempts to segregate the Work by known contracting activities. In the final analysis, the General Contractor shall be responsible for scoping the work for each trade based on local practice to include all the Work of a given type in the related proposal, regardless of where and how identified in the Bid Documents.

### 26 00 02 SCOPE OF WORK

- A. This project is for a renovated recreation center HVAC system for the University of Missouri Columbia located at 1000 Rollins Street, Columbia, MO. The design, defined by the Project Documents, provides for recreation facilities.
- B. The Electrical Work for this project shall include all material, labor and services necessary for and incidental to providing the following systems (respective Sections of the Specifications are noted in the right hand column):
  - 1. Basic Electrical Requirements 26 00 00
  - 2. Common Work Results for Electrical 26 05 00
  - 3. Low Voltage Electrical Transmission 26 20 00

### 26 00 03 REFERENCES, RELATED SECTIONS of the SPECIFICATIONS

- A. The Plans, the general provisions of the of the Contract, including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Division 26 of the Specifications.
- B. All provisions and conditions cited in this Section shall apply to Work for all other sections of Division 26 of these Specifications.
- C. Requirements of the following Sections of the Specifications apply to Work for this Section:

### 26 00 04 REFERENCES, REGULATORY REQUIREMENTS

- A. All material and equipment shall be listed, labeled or certified by Underwriters Laboratories, Inc., where relevant standards have been established (see also Paragraph 26 00 60). Material and equipment, which are not covered by UL Standards, will be acceptable provided they meet safety requirements of a nationally recognized testing laboratory. Products which no nationally recognized testing laboratory accepts, lists, labels, certifies or determines to be safe will be considered if inspected or tested in accordance with national industrial standards such as NEMA or ANSI. Evidence of compliance shall include test reports and definitive submittals.

B. Definitions:

1. **“Listed”**: A product is “listed” if of a kind mentioned in a list which: Is published by a nationally recognized laboratory which makes periodic inspections of such production. States that such product meets nationally recognized standards or has been tested and found safe for use in a specified manner.
2. **“Labeled”**: The product is “labeled” if: It embodies a valid label or other identifying mark of a nationally recognized testing laboratory such as UL, Inc. Production is inspected periodically by a nationally recognized testing laboratory. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
3. **“Certified”**: The product is “certified” if: The product has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in specific manner. Production is inspected periodically by a nationally recognized testing laboratory. The product bears a label, tag or other record of certification.

26 00 05 DEFINITIONS

- A. The term **“Work”** used in this Division shall be the furnishing of material, labor and/or services necessary for and reasonably incidental to providing specific component(s), consideration(s) and/or system(s) of the design for the mechanical facilities for this Project as hereinafter defined by the Project Documents.
- B. The term **“Project Documents”** used in this Division shall be the compilation of the Specifications, the Plans and any Attachment and Addendum which collectively define the design and the intent of the Work to construct the Project.
- C. The terms **“Architect”** and **“Engineer”** as used in this Division of the Specifications shall be the professional individual and/or company developing the respective portion(s) of the Project Documents and administering the responsibility for the adherence to the intent of these documents. The “Architect/Engineer” is the agent of the “Owner” and shall represent and discharge authority on all matters unless the matter is referred to the Owner or the Owner elects to perform in their own behalf.
- D. The term **“General Contractor, Construction Manager, or Prime Contractor”** as used in Division 26 shall mean the Contractor who has the prime contract with the Owner and who is responsible for general conditions of the project and is responsible for seeking experienced and qualified Trade Subcontractors to perform the Work.
- E. The terms **“Contractor”** and **“Subcontractor”** where used in this Division shall mean any Company, regularly in business, to perform the type of work for which the Contract was sought, who has contracted with the Owner or General Contractor to perform the work included in and defined by this section and any other section or sections of this Division.
- F. The term **“submittal”** as used in this Section of the Specifications shall be construed to be information in various forms compiled by the Contractor to transmit to the Architect/Engineer for review, comment and/or approval and return same to the Contractor with notice to react. The information shall support and/or substantiate that the given product complies with the intent of the Project Documents, should be incorporated in the Work and therefore, warrants approval to permit proceeding with that Work. The information may be any form or accepted practice of shop drawings, data, published catalogs, etc. that sufficiently provide the Architect/Engineer with basis of making a determination.

- G. The term **“unfinished space”** as used in Division 26 of the Specifications shall be a mechanical or electrical equipment room. These are rooms that are generally unpainted and accessible only to building maintenance personnel.
- H. The term **“finished space”** as used in Division 26 of the Specifications shall mean any space not defined as “unfinished space” (i.e. occupied rooms, corridors, stairways, closets, etc.).
- I. The term **“exterior”** or **“outdoors”** as used in Division 26 of the Specifications shall mean exposed to atmospheric weather conditions.
- J. The term **“interior”** or **“indoors”** as used in Division 26 of the Specifications shall mean not exposed to atmospheric weather conditions.
- K. The term **“concealed”** as used in Division 26 of the Specifications shall mean anything that is not visible in a “finished space”.
- L. The term **“inaccessible”** as used in Division 26 of the Specifications shall mean located within walls or above non-lay-in ceiling (i.e., drywall, plaster).
- M. The term **“packaged”** as used in Division 26 of the Specifications shall be construed to be a factory manufactured piece of equipment for which all components are totally assembled, pre-piped and prewired within its own structure and ready to operate when connected to proper external mechanical and electrical services.

26 00 06 CODES, STANDARDS, etc.

- A. The material, workmanship and systems for Work of this Division shall comply with all applicable codes, standards, regulations and laws of the legal governmental jurisdiction at the project site.
- B. Should the Contractor perform any work that does not comply with the requirements of the applicable codes, standards, regulations, statutes, laws, acts, or which does not receive the approval of the responsible inspection authority, Contractor shall bear all costs arising in correcting the deficiencies.
- C. Applicable requirements of the current and accepted edition of the following codes shall apply to the Work for Divisions 26 - 28:
  - International Building Code 2018
  - International Existing Building Code 2018
  - International Mechanical Code 2018
  - International Plumbing Code 2018
  - International Fire Code 2018
  - International Fuel Gas Code 2018
  - International Energy Conservation Code 2018
  - Uniform Plumbing Code, 2018
  - National Electrical Code, 2017
  - Code of Federal Regulations (CFR)
  - Code of State of Missouri Regulation
- D. Applicable requirements of the current and accepted edition of the following industry standards, codes and specifications shall apply to the Work for Division 26-28:

ANSI	American National Standards Institute
ASTM	American Society of Testing and Materials

IEEE	Institute of Electrical & Electronic Engineers
IPCEA	Insulated Power Cable Engineers Association
NIST	Institute of Science and Technology
NEC	National Electric Code, including amendments by local authority having jurisdiction
NEMA	National Electrical Manufacturers Association
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Act
UL	Underwriters Laboratory, Inc.

- E. Applicable requirements of all the relevant Federal laws including current and accepted edition of the Americans with Disabilities Act (ADA).



## **26 00 20 CONDITIONS, JOBSITE**

### 26 00 21 TEMPORARY FACILITIES

#### A. General

In general, the **General Contractor/Construction Manager** or the Owner to the extent as described in Division 1 of the Specifications will provide temporary facilities. However, if that is not the case, the specific conditions of this project are identified as follows:

#### B. CONSTRUCTION ELECTRIC POWER and LIGHTING: Edit to suit project

1. The Owner will allow Contractor to utilize 120V, 60 HZ, single phase building power via convenience outlets for hand tools and to use the building's permanent lighting during construction, to the extent feasible.
2. It shall be the responsibility of the respective Contractor or Subcontractor to provide extension(s) and any necessary protection devices from the distribution panel(s) for their requirement(s). All cords shall be grounded.
3. The Contractor shall maintain temporary lighting to provide minimum illumination levels in accordance with OSHA 1926.56.
4. The Contractor shall maintain temporary convenience power such that no point in the building is further than 50 feet from a distribution panel. It shall be the responsibility of the respective Contractor or Subcontractor to provide extension(s) and any necessary protection devices from the distribution panel(s) for their requirement(s). All cords shall be grounded and GFCI protected.
5. The respective Contractor or Subcontractor shall provide their own three (3) phase electric power requirements.

#### C. TEMPORARY TOILETS and WATER:

1. The Owner will permit the Contractor to use toilets designated by the Owner and to use the building's domestic water faucets and hose bibs.
2. The Contractor shall keep the toilet areas clean and in full working order during construction.
3. Any connections to the domestic water which could cause contamination shall be connected via a backflow prevention device.

#### D. JOB SITE SECURITY:

1. The Contractor shall cooperate with the Owner in the procedures and requirements for entering and exiting the building.

2. The Contractors work hours shall conform to the building's normal operating hours unless special arrangements are made with the Owner.
3. Each trade shall be responsible for securing its trailers, lockboxes, materials, supplies, tools, etc. and Owner will not be responsible for damage, theft, or loss.

E. JOB SITE PARKING:

1. The Contractor shall park in only the designated areas assigned to them for use by the **Owner** and shall not park in No Parking Areas, on lawns, or unpaved areas and shall not block access to loading docks, fire hydrants, etc.

26 00 22 REQUIREMENTS TO PURSUE THE WORK

- A. Work space: The respective Contractors and Subcontractors shall be assigned areas at the job site for construction trailers, lay-down, storage and work spaces as arranged with the **Owner**. All spaces shall be accessible to the Architect/Engineer. All material and equipment shall be protected during the course of construction against weather, dirt, comprehensive damage and theft. All items subject to water damage shall be adequately protected. Damage occurring or defects detected before acceptance shall be repaired or replaced at no additional compensation.
- B. Tools: The Contractors and Subcontractors shall provide their own tools and services to perform their respective Work. Rented or leased services shall have proper and adequate insurance.
- C. Temporary storage: The Contractors and Subcontractors shall be responsible for any requirements to temporarily store material and equipment until it is incorporated into the Project.

## **26 00 30 PROJECT DOCUMENTS**

### 26 00 31 GENERAL

- A. The Plans and the Specifications are intended to define complete and satisfactorily functioning systems. The Contractor shall be responsible for providing all necessary material, labor and services to provide the completed, operating systems at no additional compensation even though each and every element thereof is not specifically identified.
- B. The Plans are diagrammatic and indicate general arrangements, approximate sizes and relative locations of principal equipment and materials to provide for the design and intent of the Electrical Work and shall be followed as closely as actual building and site conditions and work of other trades will permit. The Work shall conform to the requirements and intent of the Project Documents. Because of the scale of the drawings, the Plans do not represent every offset, fitting, accessory, etc. that may be required for the conduit or other appurtenances, nor is it implied that all conflicts between elements of the Work or building components have been resolved. The Contractor shall prepare details and/or coordination drawings where it may be required and submit to the Architect/Engineer for approval before proceeding with the Work.
- C. To the extent contained in the Project Documents, elevations, sections, typical details, and schematic diagrams are included for instructions to the craftsman. If any additional diagrams are desired and/or required for further instruction to the craftsman, for permit applications, or for any other reason, the Contractor shall develop the drawings.
- D. Significant discrepancies and/or changes required to accomplish the intent of the Project Documents, in the opinion of the Contractor, shall be identified and submitted to the Architect/Engineer for approval before proceeding with the Work in question. Changes originated by the Architect/Engineer shall be processed under the subsection heading "Changes in the Work".
- E. The Plans and the Specifications are mutually complementary. Work required by one, but not the other, shall be performed as if required by both.
- F. In the event of conflict between the Plans and the Specifications, the Contractor shall notify the Engineer for clarification. Prior to clarification, the Contractor shall assume that the stricter requirements apply.

### 26 00 33 SPECIFICATIONS

- A. Referenced sections of other Divisions whether attached or in separate volumes or binders shall be a part of the Contract Documents.

### 26 00 34 ADDENDA

- A. The Architect/Engineer may issue revisions, modifications, attachments or other documentation in the form of addenda to the Project (Bid) Documents during the bidding phase only to change, detail or clarify the scope of the Work.
- B. The addenda shall become a part of the Contract Documents.

26 00 35 INTERPRETATIONS

- A. The electrical Engineer shall be the sole source of interpretation of the electrical design and intent of the Project Documents.

26 00 36 CONSTRUCTION SCHEDULE

- A. The Contractor shall furnish sufficient manpower as the schedule dictates and is required to maintain the overall project schedule. Manpower or overtime to meet the project schedule including, but not limited to, premium time, inefficiencies associated with longer days/hours, inefficiencies associated with additional manpower, or other labor burdens shall be included in the Contract Sum.
- B. The Contractor shall coordinate with their Subcontractors to develop an overall project schedule.

26 00 37 AS-BUILT DRAWINGS

- A. The Contractor shall maintain a separate set of plans at the jobsite, and mark thereon as an As-Built of Work as the construction proceeds. These As-Built, "redline" drawings shall include exact locations and relevant details (i.e. elevations, sizes, dimensions related to building lines, etc.) of all underground work, concealed feeders, pull/junction boxes, cable tray, all considerations requiring periodic attention and access thereto.
- B. At the completion of the project, the Contractor shall provide the "redline", scanned color PDF of the As-Built, flattened to the Engineer.
- C. At the completion of the project, the Architect/Engineer will provide PDF drawings (including all issued revisions to the Contract) for the Contractor's use to transfer all of the information from the As-Built drawings to a final, clean set.
- D. At the completion of the project, the Architect/Engineer will provide Contractor CAD files for the Contractor's use to transfer the information on the drawings to CAD. The layering system on the drawings provided shall be strictly adhered to. The Contractor for their representation and accuracy of the final installation conditions shall certify these As-Built drawings. The As-Built CAD drawings shall be submitted to the Engineer digitally via thumb drive, shared cloud drive, etc. for review.

## **26 00 40 DUTIES OF CONTRACTOR**

### 26 00 41 GENERAL (Pursuit of Work)

- A. The Contractor shall thoroughly examine all Bid Documents before submitting a bid/proposal for the Work. If, in the opinion of the Contractor, there are any deficiencies in the Documents, that might impact the intent or the scope of the work, the Contractor shall bring the matter to the attention of the Architect/Engineer for clarification. If in the judgment of the Architect/Engineer clarification is warranted, an addendum to the Documents will be issued. If the Contractor fails to request clarification or otherwise submits a bid without qualifications, the Contractor thereby agrees to install a complete and functional system with no change in the contract price.
- B. The Contractor shall be responsible for changes required for compliance with codes, standards, regulations, ordinances, etc. and implementing any such change at no change in contract price. In the event of conflict with the Project Documents or other requirements, the more stringent shall apply. The Contractor shall promptly notify the Architect/Engineer of any discrepancy.
- C. The Contractor shall perform the Work to comply with all terms, conditions and intentions, whether explicit or implicit, of this Section and applicable requirements of other Sections of Division 26, the Plans and any other documentation so identified. Should the Contractor perform any Work that does not comply with the Project Documents or is not in accordance with common trade practices, the Contractor shall bear all costs, at no change in contract price, arising in correcting the Work.
- D. The Contractor shall be responsible for all aspects of the Work for their respective contractual agreement. The Work of the respective suppliers and subcontractors shall be administered properly to assure that all elements thereof have been provided for complete and functioning system(s).

### 26 00 43 SUBMITTALS for APPROVAL

- A. All shop drawings must be submitted prior to the receipt of the second partial payment request. No further payment will be made until shop drawings have been submitted.
- B. The Contractor shall forward the quantity required for distribution within a reasonable time following the award of the contract. Prior to submitting shop drawings, Contractor shall verify equipment delivery for compliance with the overall project schedule. Any delays due to delivery or due to submittals being late, inadequate, or incorrect and therefore rejected by the Architect/Engineer shall be the responsibility of the Contractor making said submittal. The Contractor shall bear all cost for expediting charges or obtaining materials from another vendor to meet the overall project schedule.
- C. The Engineer may take up to two (2) weeks to review a complete and properly processed submittal from the time it arrives at the Engineer's office until the time it is returned to the Architect. Resubmittals will be reviewed within two (2) weeks for a complete and properly processed resubmittal from the time they arrive at the Engineer's office until the time they are returned to the Contractor.
- D. The submittals shall include shop drawings, engineering data and support information to sufficiently substantiate compliance with the Project Documents. All submittals must include the following information in order to be considered for review. Submittals found to be lacking may be rejected without review.

1. Shop drawing shall be derived from manufacturers original documents. Reproductions shall be of sufficient quality to accommodate a review.
  2. Stamped date of receipt by the Contractor(s).
  3. Identification of the project name and/or Owner's project number.
  4. Indication that the Contractor has reviewed the submittal and is satisfied that it complies with the Project Documents.
  5. Identification of the Specification section or subsection that specifies the submitted item.
  6. Identification of the submitted item by the same description that is used in the Project Documents.
- E. Submittals shall be delivered to the Engineer digitally via email, thumb drive, shared cloud drive, or other agreed upon means for review. Submittals or submittal notices that are emailed shall be sent to [CA@mcclureeng.com](mailto:CA@mcclureeng.com) at a minimum.
- F. The approval of the submittal shall not relieve the Contractor from complying with all of the terms and conditions of the Project Documents. The Contractor shall be responsible for all physical and performance requirements of equipment provided, including any differences in the cost of installation for variations from these requirements.
- G. Include the manufacturer's installation instructions and maintenance manual with the equipment submittal for approval for inclusion in the Operations and Maintenance Manuals as specified in Subsection 26 00 46.
- H. In general, all items purchased by Contractor for installation where a make and model is specified shall require submittals. Items required for the Work such as screws, bolts, clips, etc. which are not specified are not required to be submitted unless specifically requested.
- I. The following shall be submitted under this Division of the specifications:
1. List of subcontractors and equipment supplier.
  2. Payment breakdown.
  3. Detailed submittals.
  4. Catalog Data
  5. Operating and maintenance manuals.
  6. As-built drawings.
  7. Contractor developed details and coordination drawings (when applicable).
  8. Proposed substitution (when applicable).

Division 26

1. Wiring Devices
2. Seismic, Sway Bracing, Anchorage Details/Drawings
3. Main Switchboard
4. Disconnect Switches

5. Distribution Panelboards
  6. Circuit Breaker Panelboards
  7. Surge Protective Devices
  8. Metering Devices and Accessories
  9. Fuses
  10. Motor Starters / RIB (relay in a box) / Contactors
  11. Variable Frequency Drives
  12. Light Fixtures
  13. Low Voltage Lighting Control Systems
  14. Occupancy Sensors / Digital Timers
- J. At the completion of the project provide a single PDF document containing only those shop drawings that were approved and incorporated into the project.

26 00 44 CHANGES IN WORK

- A. The only condition under which a change in the contract price will be considered is if there is to be a change in the scope of intent of the project requirements. Such changes would be limited to revisions in the project initiated by the Owner. The Architect/Engineer will issue a proposal for the new scope of work for the Contractor to prepare a price. After approval, the Architect/Engineer will prepare change order or change orders to adjust the contract sum and/or the contract time as necessary to carry out the changes.
- B. No claim for an addition to the Contract Sum will be valid unless authorized as aforesaid in writing by the Owner. Any work completed by the Contractor outside the original project scope without written approval from the Owner will be deemed as a waiver by the Contractor for additional compensation for said work.
- C. No requests for change orders will be reviewed or considered for approval that are not submitted with all of the following information. No cost associated with labor burden or manpower inefficiencies will be approved for a change order without documentation of the present labor burden, manpower requirements, and the critical path nature of the scope change.
1. A complete and detailed line item takeoff of materials and equipment.
  2. A unit cost identified for each line item with material cost, labor hours, and labor rate identified separately for each line item.
  3. All fringes and mark-ups identified separately.
- D. Where major subcontracts are involved, the respective subcontractor's calculation, including all of the above data, shall be included with the Contractor's request.
- E. Where there are net differences, the above data shall be included for all items added and for all items deducted with the net calculation clearly identified. Mark-ups shall be applied only after net differences are calculated.

- F. The overhead charged by the Contractor shall be considered to include, but not limited to, performance bond, insurance, job site office expense, normal hand tools, man-lifts, incidental job supervision, field supervision, safety training, general office overhead, and cost associated with the preparation of design documents, layout drawings, shop drawings, or as-built drawings.
- G. In evaluating the value of the contractor's request, for comparison purposes, the Architect/Engineer may use cost and unit data from the current edition of the R. S. Means Company's Cost Data, or information from appropriate suppliers or vendors of the respective materials or equipment.
- H. Any requests submitted without the above details will be returned without review for resubmittal in the proper form.

#### 26 00 45 COMPLETION and ACCEPTANCE

- A. If, at the Owner's direction, a portion of the building is to be occupied or a portion of the Electrical System is utilized for beneficial use by the Owner prior to completion and acceptance of the Project, the start of the warranty shall begin with the "beneficial use" of the related Work.
- B. The Engineer shall inspect the portion of the system for approval prior to acceptance of the system or subsystem.
- C. The Contractor shall prepare a certificate of acceptance for approval by the Owner for that portion of the Work and submit a copy to the Architect/Engineer for record purposes.

#### 26 00 46 OPERATIONS AND MAINTENANCE MANUALS

- A. As a part of the contractual agreement, the Contractor shall submit and receive approval for the following to receive payment beyond 75% of the contract amount. This information shall be submitted as soon as practical and while the Contractor is on site.
  - 1. Provide digital PDF documents containing information on installation operation and maintenance for each piece of equipment supplied. Operation and Maintenance Manuals shall be the manufacturers original PDF documents.
  - 2. The Electrical Operations and Maintenance Manuals shall be submitted as separate files per specification section to the Engineer digitally via thumb drive, shared cloud drive, etc. for review.
  - 3. The information shall list any maintenance requirements and schedule for required maintenance.
  - 4. The information shall show all parts and part numbers of available replacement parts available for each piece of equipment.
  - 5. A cross-index of material and equipment furnished containing:
    - a. An alphabetical listing of material and equipment.
    - b. An alphabetical listing by manufacturer's name, address and contact person of the local sales representative.
    - c. An alphabetical listing of all subcontractors including name, address, contact person, and specific work performed.

#### 26 00 48 CLOSE-OUT REQUIREMENTS



- A. As a part of the contractual agreement, the Contractor shall submit and receive approval for the following before final payment will be released. This information shall be submitted prior to project completion:
1. Equipment tag list.
  2. Installed Arc-Flash Labels
  3. Equipment Name Plates
  4. Operation and Maintenance Manuals
  5. As-built drawings.
  6. At the completion of the project, all contractors/subcontractors shall submit a letter stating all materials are asbestos free, and meet the specified ASTM E-84 flame/smoke rating of 25/50, and that all penetrations are smoke or fire stopped as required by the Code.

26 00 49 GUARANTEE

- A. The Contractor shall guarantee all material, equipment and workmanship provided for this project to be free from defects for a period of one (1) year after final acceptance. The guarantee shall include replacement of the defective part(s) and related labor. Manufacturer's written guarantees shall be provided where it is published.
- B. Any obvious defects shall be corrected before final acceptance. For additional defects after final acceptance, the Owner shall advise the Contractor in writing, unless the situation is urgent, to address the deficiency or malfunction. The Contractor shall respond promptly and with no additional compensation for a valid guarantee claim.
- C. Longer guarantee periods of time or special conditions may be specified. See particular specifications for these requirements.
- D. If a written guarantee is offered for conditions or period exceeding specified requirements; this guarantee shall be included in the "Close-out" specifications of Subsection 26 00 48.
- E. The Contractor shall not qualify the guarantee with requirements placed upon the Owner. If the Contractor has concerns with maintenance of a piece of equipment then Contractor shall allow for making periodic inspections, adjustments, etc. during the warranty period.

## **26 00 50 PAYMENTS**

- A. The Contractor shall submit for approval by the Architect/Engineer, at least four (4) weeks prior to the first request for payment, a format utilizing AIA form G702 of an itemized cost breakdown of all systems (material and labor), subsystems (material and labor), and major equipment groups to be invoiced for progress payments.
- B. The Contractors of Divisions 26 - 28 will also be subjected to the following requirements for payments in addition to the requirements specified in the General Conditions or Division 1:
  - 1. The Contractor shall submit all shop drawings [except temperature control and sprinkler drawings] prior to receiving the second partial payment, see Section 26 00 43.
  - 2. Payments will be for the total of the approved payment request, less a retainage of 10%.
  - 3. The Contractor shall submit Operations and Maintenance Manuals and Catalog Data prior to receiving payment beyond 75% of the contract amount, see sections 26 00 46 and 26 00 47, respectively.
  - 4. The Contractor shall submit Closeout Documents prior to receiving final payment, see section 26 00 48.

## **26 00 60 MATERIAL AND EQUIPMENT**

- A. All equipment and materials furnished and installed by Contractor shall be new. The equipment to be furnished and installed shall be standard cataloged products of manufacturers regularly engaged in the production of this type of equipment and shall be of the latest design. Equipment of the same general type shall be of the same make throughout the Project.
- B. Manufacturers shall have been in business for two (2) consecutive years operating under the same name.
- C. Products shall be in production at time of the bid date. A scheduled release of a new product during construction is not acceptable. Prototype, alpha or beta products shall not be used.
- D. Products for which fewer than 100 units have been produced and which have been in service for less than one year shall be submitted in writing to the Engineer for approval prior to the bid date.
- E. The Contractor shall be responsible for the physical fit and configuration of the equipment to suit the space available and the intent of the Work. Due consideration shall be included for external connections and service maintenance access to the equipment.
- F. The Contractor shall verify in the course of preparing the submittal that the respective material and equipment comply with the following criteria of the Project Documents:
- G. The performance ratings meet the specified requirements.
- H. The mechanical and electrical physical characteristics meet the specified requirements.
- I. The identification of the material or equipment to catalog data is correct and proper.
- J. Confirm (or establish) the quantity required.
- K. The application of the material or equipment is acceptable to the manufacturer and to the intent of the scope of Work.
- L. Any inability of material and/or equipment to comply with the aforementioned criteria shall be promptly brought to the attention of Architect/Engineer.

## **26 00 61 EQUIPMENT MANUFACTURERS**

- A. The equipment manufacturer may be specified in any one of the following manners. Equivalent shall mean, equivalent in the opinion of the Engineer. Where equipment is scheduled on the drawings, the scheduled manufacturer is what the design is based upon:
  - 1. Single manufacturer named, "No substitution allowed":
  - 2. Single manufacturer named followed by "or approved equivalent":  
The design has been based on this particular make and model for acceptable physical characteristics, performance and quality. Any other comparable and equivalent product may be substituted in accordance with procedures for submittals and approvals (Subsection 26 00 43) and conditions of Subsection 26 00 62, Equipment substitution.
  - 3. Limited multiple manufacturers named:  
The design has been based on the first named manufacturer for acceptable physical characteristics, performance and quality. Any one of the other limited named

manufacturers is equally acceptable in quality and may be substituted in accordance with procedures for submittals and approvals (Subsection 26 0043) and conditions of Subsection 26 00 62, Equipment substitution.

4. Limited multiple manufacturers named followed by “or approved equivalent”:

The design is based on the first named manufacturer for acceptable physical characteristics, performance and quality. Any one of the other limited named manufacturers is equally acceptable in quality and along with other comparable and equivalent product may be substituted in accordance with procedures for submittals and approvals (Subsection 26 00 43) and conditions of Subsection 26 00 62, Equipment substitution.

5. List of “Acceptable Manufacturers”:

Where a specific product from a manufacturer is listed along with the words “Acceptable Manufacturers” and a list of manufacturers this equal product(s) of any of the limited list may be submitted without concern from Subsection 26 00 62.

- B. The Contractor shall follow the option specified from above as applied to each respective material and equipment specification subsection. The Contractor shall indicate within the options allowed the respective supply source(s) for the listing requested in Subsection 26 00 43. The Contractor shall assume all responsibilities and liabilities of “or equivalent” substitutions (see Subsection 26 00 62).
- C. The Contractor shall prepare and transmit submittals for approval, even for the option of Subsection 26 00 61.1.

26 00 62 EQUIPMENT SUBSTITUTION

- A. General: As previously stated, the design has been based on a single manufacturer and model. Substitution, where permitted (as described above), may cause consequential effects that may impact on the Project. These effects may take various forms and may require changes in the design. These changes and any additional costs associated therewith are the responsibility of the Contractor proposing the substitution; no additional compensation shall be provided to the Contractor.
- B. A possible change in design may result from the proposed substitution from one or more of, but not limited to, the following conditions:
1. Architectural: different physical configuration, size or fit, aesthetics effected.
  2. Structural: different bearing or heavier loading.
  3. Capacity: different performance, lesser output is unacceptable.
  4. Mechanical: change in flow rates (air, water, etc.), different configuration and size of external piping or ductwork connections.
  5. Electrical: different horsepower requirements, effect on distribution.
  6. Controls: interconnections with control devices and equipment, additional requirements.
  7. Impact on environmental or energy efficiency issues.
  8. Departure from intent of original design or Project Documents.
- C. Changes in loading, sizing and/or performance of the proposed substitution shall consider the total requirements served or needed by the particular equipment. A revised design to

accommodate the substitution shall be extended to the point where the change has no effect on the parameters used in the original design.

- D. An equipment substitution requiring a change in the design shall be processed as follows:
1. The Contractor shall prepare and submit to the Architect/Engineer for review, a proposal to provide a substitution that shall require a change in the design. Substantiate that the substitution complies with the intent of the Project Documents and include sufficient information of the changes required so that a judgment may be rendered.
  2. Proposal shall include an original drawing originated by the Contractor, and shall not be a catalog cut, assembly manual, or other generic documented printed by the manufacturer or their representative. The design shall show the intended installation to the same level of detail as that of the original design.
  3. Prior to submitting the proposal, the Contractor shall notify all other contractors whose work may be affected and request details and pricing for their respective changes. This information along with the Contractor's details shall be transmitted to the Architect/Engineer for approval.
  4. The Contractor in preparing the proposal recognizes that they shall compensate other trades that are affected by said proposal.
  5. If the proposal and the substitution are acceptable, the Architect/Engineer will approve the submittal and initiate a change order, at no additional compensation, and a notice to proceed.
- E. Equipment that was listed as a multiple manufacturer with a model number shall be submitted as a shop drawing. Contractor shall be responsible for all other provisions of Section 26 00 52. If, and only if, the material or equipment substitution requires no design change, the Work shall proceed in accordance with the Product Documents.
- F. Equipment that is being proposed as 'or equivalent' or was listed as a multiple manufacturer without a model number shall be in the form of a written proposal before the shop drawing phase. 'Or equivalent' shall mean or equivalent in the opinion of the Architect/Engineer and they shall have sole discretion to determine whether or not a proposed substitute manufacturer and/or model is to be considered as acceptably equivalent and may be submitted in the form of shop drawings. If, and only if, the material or equipment substitution requires no design change, the Work shall proceed in accordance with the Project Documents.
- G. If changes are in fact required or a delay in work occurs because of the material or equipment substitution which were not properly processed, the Contractor initiating the substitution shall be liable for all consequential effects and expenses to accommodate the change or delay.

#### 26 00 63 MOTORS

- A. The following are basic minimum requirements for all motors. Additional motors, more detailed and specific requirements may be specified with the respective equipment.
- B. Single-phase motors shall be provided for all motors 1/2 HP or less, except as specified or scheduled otherwise and shall be of the permanent split capacitor (PSC) type.
- C. Polyphase motors shall be provided for all motors 3/4 HP or larger, except as specified or scheduled otherwise with a minimum power factor of .85 at 65% of full load or shall be power factor corrected.
- D. Multi-speed motors shall have dual windings wound to the speeds scheduled or specified.

- E. Torque characteristics shall be sufficient to satisfactorily accelerate the driven load(s) with low inrush current.
- F. Motor horsepower sizes shall be large enough so that the driven load shall not require the motor to operate in the service factor range.
- G. Temperature rating: Rated for 40 deg. C environment with maximum temperature rise for continuous duty at full load of 40°C for open dripproof motors, 50°C for splash proof motors, and 55°C for totally enclosed motors (Class B insulation). Motors used with variable frequency drives/inverters shall have a Class B temperature rise with Class F insulation design to resist transient spikes, high frequencies, and short rise time pulses produced by inverters.
- H. Starting capability: Frequency of starts as specified by the automatic control system. For manually controlled motors, not less than five (5) evenly time spaced starts per hour.
- I. Service factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- J. Motor construction:
  - 1. NEMA standard frame sizes, general-purpose open dripproof (unless otherwise specified), continuous duty, Design "B" (unless "C" is required for high starting torque). Motor frame, end bells and conduit box shall be cast iron; stator windings shall be copper. Aluminum is unacceptable for any parts. Provide grounding lug in motor terminal box.
  - 2. Motors located outdoors or otherwise exposed to water, dust, etc where an open motor would not be suited, shall be totally enclosed fan-cooled (TEFC).
  - 3. Bearings: Ball or roller bearings with inner and outer shaft seals. Externally accessible inlet/outlet grease fittings. Where motors are enclosed within equipment, extend grease tubing to exterior of the enclosure. Bearings designed to resist thrust loading for drives producing lateral or axial thrust. Fractional horsepower, light duty motors may have sleeve bearings.
  - 4. Overload protection: Built-in thermal overload protection.
  - 5. Noise rating: Motors shall meet IEEE, Standard 85.
  - 6. Efficiency: Motors shall be NEMA Premium Efficiency per NEMA Standards Publication MG 1-2003, Table 12-12 and 12-13.
  - 7. Nameplate: Indicate full identification of manufacturer's name, model number, serial number, horsepower, speed, voltage, characteristics, construction, special features, etc. Nameplates in harsh environments such as for cooling towers, or in pool equipment rooms, etc. shall be suited to the specific application.
- K. Acceptable manufacturers: Baldor, General Electric by ABB, Gould, Marathon, Magnetek, Reliance, Siemens, Toshiba, and U.S. motors.

## **26 00 70 BASIC ELECTRICAL METHODS - GENERAL**

### 26 00 71 COORDINATION OF WORK

- A. The Contractor shall compare the electrical drawings and specifications with the site conditions, drawings and specifications of other trades and shall report any discrepancies between them to the Architect and obtain from them written permission for changes necessary in the electrical work. The Contractor at no addition to the contract price shall perform any such changes required. The electrical work shall be installed in cooperation with other trades installing interrelated work. Before installation, the Contractor shall make proper provisions to avoid interference in a manner approved by the Architect. All changes required in the work of the Contractor caused by their neglect to properly coordinate the work shall be made by them at their own expense.
- B. In new construction, anchor bolts, sleeves, inserts and supports required for the electrical work shall be furnished under the same Section of the Specifications as the respective items to be supported; and they shall be installed, except as otherwise specified, by the trade furnishing them in cooperation with the trade furnishing and installing the material in which they are to be located. It shall be the responsibility of the Contractor who locates the anchor bolts, sleeves, inserts and supports to also ensure that they are properly and safely installed.
- C. Slots, chases, openings, and recesses through floors, walls, ceilings, partitions, and roofs shall be provided as the building is erected. It shall be the responsibility of the Contractor or trade requiring and providing the opening to verify the size and location of openings required and to furnish necessary sleeves, boxes, etc., for the equipment to be supplied. Patching of oversize openings and finished thereof shall be the responsibility of the trade or Contractor requiring the opening. All patching and finishing shall be done to match the adjacent materials as described in other respective divisions and sections of the specifications. No openings shall be cut in structural members without prior written approval of the Architect.
- D. Locations of conduits, electrical raceways, switches, panels, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The Contractor shall determine the exact route and location of each conduit, duct and electrical raceway prior to fabrication. If the Contractor fails to do so, any relocation and reinstallation required will be directed by the Architect and must be implemented by the Contractor at no cost to the Owner.
- E. Right-of-way: Lines which pitch shall have the right of way over those which do not pitch. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed. Offsets, transitions and changes in direction in pipes and buss ducts shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the drawings. The Contractor shall furnish and install all elbows, pullboxes, turns, fittings, supports, etc., as required to affect these offsets, transitions and changes in direction.

### 26 00 72 STORAGE AND INSTALLATION OF EQUIPMENT AND ACCESSORIES

- A. Equipment and materials shall be delivered to the site, stored in location(s) approved by the Architect, and suitably sheltered from the weather, but readily accessible for inspection by the Owner. All items subject to moisture damage shall be stored in dry, heated spaces. All equipment shall be covered and protected against dirt, water and chemical or mechanical injury in a manner approved by the manufacturer and against theft, during storage, installation, and construction. Damage or defects developing before acceptance of the work shall be made good at the Contractor's expense.

- B. Manufacturer's directions shall be followed completely in the delivery, storage, protection and installation of all equipment and materials. The Contractor shall promptly notify the Architect in writing of any conflict between any requirement of the contract documents and the manufacturer's directions. They shall obtain the Architect's written instruction before proceeding with the work. In case of a difference between the installation instructions of the manufacturer and the instructions in the contract documents, the most stringent shall govern. Any costs related to changes required due to manufacturer's instructions differing from the contract documents shall be borne by the Contractor at no cost to the Owner.
- C. Should the Contractor perform any work that does not comply with the manufacturer's directions, any written instructions from the Architect, or which shall cause a significant deviation from the drawings which has not been by the Architect they shall bear all costs arising in correcting the deficiencies in a manner directed by the Architect.
- D. Where switchgear, motor controls, transformers, or other electrical equipment is located in a space with a concrete or other type of paved flooring, it shall be set on a raised concrete pad. Unless otherwise noted on drawings or elsewhere in these specifications, concrete pads and bases shall be furnished and installed by the Contractor furnishing the equipment. This Contractor shall establish sizes and location of the various concrete bases required and shall provide all necessary anchor bolts together with templates for holding these bolts in position. Anchor bolts shall be placed in steel pipe sleeves to allow for adjustment, with a suitable plate at bottom end of sleeve to hold the bolt. Each concrete base shall be not less than 9" high, unless noted otherwise, which shall project 1-1/2" beyond the equipment on all sides.
- E. Where equipment is located in a space where it does not rest on a concrete or similar paved floor, it shall be supported from or on the available structure on a structural frame made of suitable channels, wide flange members or angles. The structural frames shall allow no deflection with the loads imposed and the respective supporting points, shall distribute the load equally to two or more major building structural elements, and shall be designed to carry all loads into the major building structural members, creating no measurable deflection on these members nor importing any vibration into the building structure.
- F. All machinery which contains rotating or reciprocating parts or which is connected to other machinery with such parts shall be provided with vibration isolation mounts which shall be selected at a maximum transmissibility of 0.03 (isolation efficiency of 97%) at the lowest anticipated operating speed of the device.
- G. The Contractor shall support plumb, rigid and true-to-line all work and equipment furnished under each section. The Contractor shall study thoroughly all general, structural, mechanical and electrical drawings, shop drawings and catalog data to determine how equipment, fixtures, etc., are to be supported, mounted or suspended and shall provide steel bolts, inserts, pipe stands, brackets, and accessories for proper support whether or not shown on drawings. When directed by the Architect, the Contractor shall submit drawings showing supports for approval.
- H. All conduit connecting to switchgear, panels, motors, and other equipment shall be installed without strain at the connections. The Contractor may be required, as directed, to disconnect conduits piping to demonstrate that they have been so connected.
- I. The Contractor shall install all electrical work to permit removal (without damage to other parts) of switches, contactors, motors, drawout circuit breakers, belt guards, sheaves and drives and all other parts requiring periodic replacement and maintenance. The Contractor shall provide conduits, pullboxes, junction boxes, bus ducts, switchgear, raceways and equipment to permit ready access to components and to clear the openings of swinging and overhead doors and of access panels.



- J. The Contractor shall change the routing of conduits and buss ducts when required to meet job conditions. The Contractor shall secure approval of Owner prior to fabrication of equipment requiring such changes.

## **26 00 80 BASIC ELECTRICAL METHODS – RELATED WORK**

### 26 00 81 DEMOLITION

#### A. Work Included:

1. The Owner shall keep possession of the designated equipment, including switchgear, transformers, motors, generators, panelboards, light fixtures, etc., as shown on the Plans, or as indicated during construction, or as hereinafter specified. The Contractor shall deliver, off-load and store this property as directed by the Owner. Machinery components not to be retained by the owner, including the above type of equipment and conduit, wire, hangers, brackets, insulation, wiring devices, etc., must be disconnected and removed from the premises, to be disposed of by the Contractor.
2. Contractor shall disconnect and remove all existing machinery, equipment, and apparatus to the extent shown on the drawings or otherwise described herein.
3. The Contractor shall legally dispose of the designated equipment, and/or apparatus. Any cost of removal or salvage value shall be credited to the Contractor's account and shall be considered accordingly in the Contractor's bid.

#### B. Work Not Included:

1. The removal and disposal of asbestos based insulation or other hazardous materials applied to, or contained in, the mechanical equipment, and material designated to be demolished shall not be included in the scope of the work regardless if known ahead of time or discovered in the course of performing the Work. In the latter case, the Contractor shall notify the Architect/Engineer and shall not pursue that portion of the Work until others have removed the asbestos-based material. The removal and disposal of asbestos-based material shall be arranged by and to the account of the Owner, and conducted separately from the demolition work.

#### C. Miscellaneous:

1. Where items are specifically identified to be abandoned, all loose ends of the system shall be trimmed clear and appropriately capped or sealed in a safe and secure manner as approved by the Architect/Engineer.

### 26 00 82 CUTTING AND PATCHING

- A. The basic premise of this Sub-section is that the cutting and patching (where required) are performed in existing building components. In "new" construction, the premise is that the building component is already in place.
- B. The Contractor requiring the penetration of or the access way in the building structure to fulfill the intent of the Project Documents for their Work shall be responsible for the cutting and the subsequent patching in accordance with the following criteria:
  1. No structural component of the building shall be cut or violated without express approval of the Architect/Engineer.
  2. The Contractor shall verify the presence of any concealed utility or service within the structure (walls, roof, floor, etc.) in question, and shall be responsible for maintaining continuity and/or replacing it.
- C. Cutting of work-in-place in "new" construction because of error, neglect or damage inflicted shall be the responsibility of the Contractor precipitating the issue.
- D. "Patching" shall be construed as the repairing or replacing of the building structure to return it to an original or new condition, in the opinion of the Owner and/or Architect/Engineer, as existed prior to the cutting.

- E. Patching and finishing work shall be the responsibility of the Contractor requiring the cutting. The patching shall match all the substantive and visual aspects of the structure and adjacent surfaces. Restoration and finishes shall be as specified and executed in the respective sections, schedules and/or details of the Project Documents for the general construction work. Completed work and any special requirements shall be subject to approval by and satisfaction of the Architect/Engineer.

**26 00 90 TESTING AND ADJUSTING**

26 00 91 INSTRUCTIONS OF OWNER'S REPRESENTATIVE

- A. Instruct the designated representative of the Owner in the proper operation and maintenance of all elements of the electrical systems. A competent representative of the Contractor shall provide such formal instruction and shall spend such additional time as directed by Architect/Engineer to fully prepare Owner to operate and maintain the electrical systems.

26 00 92 TESTING AND ADJUSTING

- A. Contractor shall, at the conclusion of the project, performance test and adjust all of the electrical systems to provide performance of all systems and subsystems installed and in all areas of the building. All power systems, communication systems, control systems and other related devices and subsystems shall be operated by the Contractor for a period of no less than seventy-two (72) hours and shall be systematically tested for proper sequencing, control, connection, phasing, rotation and calibration of control devices.
- B. Testing shall be systematic and thorough, and the results of these tests shall be submitted to the Architect/Engineer prior to final acceptance of the work. The format of this testing and adjusting effort, including all measurement techniques and methods, shall be submitted sixty (60) days prior to the completion of the work. After agreement with the Architect/Engineer on the format of the testing and adjusting work, the Contractor shall perform the work and resolve any and all deficiencies as they appear during the testing. It shall be the responsibility of the Contractor to provide any and all devices required for the successful testing and adjusting of the system.

## 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

- A. Extent: The work in this division consists of furnishing material and labor required to completely execute the electrical work for this project as per drawings and as specified herein.
  
- C. Interface with Other Trades: This contractor shall connect some items furnished in place by others such as prewired mechanical control assemblies. This will require coordination and cooperation with the other contractors. The extent of the required electrical work is shown on the drawings.

### 26 05 19 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### A. Material

- 1. Provisions for Wiring: Wire and cable of the sizes and types shown on the plans and/or hereinafter specified shall be furnished and installed by the Contractor. All wire and cable shall be new soft drawn copper and shall conform to all the latest requirements of the National Electrical Code IPCEA, and meet the specifications of the ASTM. Compact Stranded Aluminum wire is acceptable for all conductors #1/0 or larger between distribution system equipment (switchgear, switchboards, panelboards, transformers). Aluminum conductors shall not be used to connect to generators or mechanical/equipment loads. Lugs rated for aluminum wire to be used at all termination points. Also, prior to terminating, aluminum wire to be wire brushed and then applied with an antioxidant joint compound.
  
- 2. Power Conductors: All feeder and branch circuit wire shall be 600V 90°C insulated of the THHN & THWN-2 type unless shown or specified to be otherwise **No wire less than No. 12 AWG shall be used except for control circuits or low voltage wiring.** All wire sizes shown are American Wire Gauge sizes.
  - a. 20A Branch Circuit Homeruns shall be sized as follows:
    - 120V: 0 – 100 feet shall be #12AWG wire minimum
    - 101 – 200 feet shall be #10AWG wire minimum
    - In excess of 200 feet shall be #8AWG wire minimum
    - 277V: 0 – 250 feet shall be #12AWG wire minimum
    - In excess of 250 feet shall be #10AWG wire minimum
  
- 3. Where conductors are upsized to account for deratings or voltage drop and are too large for the termination lugs, provide reducer pins equivalent to Burndy AYP or AYPO (offset pin). Reducer pins shall be compression type, dual rated for aluminum/copper conductors, and include an insulating cover.
  
- 4. Control Conductors: Control circuit wiring shall be No. 12 AWG or smaller stranded wire. Stranded control wire shall be provided with crimp type spade terminators. Control circuit wiring shall be color-coded or numbered using an identical number on both ends of the conductor.

#### B. Installation

- 1. All 120V and 277V single phase circuits require a dedicated neutral conductor. The neutral conductor shall be numbered and identified with associated phase conductor at the panelboard as well as all junction boxes.

2. Where circuit runs are combined, upsize conduit and conductors to accommodate for conduit fill and conductor derating respectively.
3. Metal Clad (MC) Cable
  - a. Type MC cable is permitted for wiring the final portion of light fixture branch circuits from fixture to fixture within a room or area. The MC cable may be supported by the light fixture bracing wires but shall not be supported by the ceiling grid support wires. Type MC cable is permitted for wiring from local distribution junction boxes to devices or equipment in nearby walls or ceiling space. The local distribution junction boxes should be located within 20 feet of the device or equipment served. Conduit and wiring shall be used for branch circuiting between the local distribution junction boxes and for the "homeruns" from the panels. Type MC cable is permitted to route from receptacle to receptacle through walls and through the ceiling space for the final portion of branch circuit wiring between receptacles in adjacent walls of the same room or area. Type MC cable shall not be installed where exposed.
4. BX/AC Cable
  - a. Type BX/AC cable is not permitted.

#### 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

##### A. Material

1. Contractor shall extend the existing equipment grounding system in accordance with the National Electrical Code and shall use only UL listed grounding clamps and connectors.

##### B. Installation

2. The equipment grounding system shall consist of a continuous conduit installation and a green insulated equipment grounding conductor. This grounding conductor shall be installed in every conduit or raceway with the feeder or branch circuit conductors. This grounding conductor shall be extended from the housing of every electrical load, through panelboard equipment grounding busses, to the equipment grounding bus in the main panel. The grounding bus shall be bonded to the grounded neutral bar inside the main panel using a Main Bonding Jumper.
3. When transformers are used to provide a separately derived system, the Contractor shall connect the grounding electrode conductor to the neutral bar (grounded system conductor) inside the transformer. The system bonding jumper shall also be installed inside the transformer.

#### 26 05 33 RACEWAY FOR ELECTRICAL SYSTEMS

##### A. General Requirements

1. Minimum conduit size shall be ¾" trade size for branch circuits.
2. A bushing shall be used where conduit enters a panel box or equipment enclosure.

3. Grounding Bushings shall be used to bond conduits entering a panel box or equipment that are not mechanically connected.
4. Expansion fittings shall be provided at all conduits across building expansion joints. Fittings shall be Type "AX" or "TX" as made by O-Z Electric Company, or approved equal. Provide copper bonding jumper at each expansion fitting.
5. Conduit bends shall be made with standard benders of proper size; radius of bends to be at least 6 times the diameter of the conduit. Runs between outlets shall not contain more than the equivalent of three 90-degree bends. Conduit runs shall be continuous from outlet to outlet, outlet to cabinet, etc.
6. All exposed conduits shall be installed parallel or perpendicular to the building walls or floors.
7. Conduits shall be securely fastened to or supported from the building structure. Conduits not fastened directly to building structure shall be supported by a rigid assembly, free of sway and adequately braced, connected directly to the building structure. The use of 'pencil' wire, ceiling wire, and cable hangers shall not be permitted.
8. Anchor or stake down all direct burial conduits to prevent shifting during grading and concrete pours. Spacers shall be provided for trenches with 2 or more conduits with any conduit 2" or larger.
9. Install #12AWG pull wires for tracing for all underground non-metallic empty conduits with a minimum of 12 inches of slack on each end. Pull strings shall be used for empty above grade or metallic conduits.
10. All raceways installed within 1½" of the roof deck shall be GRS or IMC. Boxes shall be offset below the 1½".
11. Conduits installed horizontally in finished spaces without ceilings shall be installed above the roof deck. These spaces include gymnasium, multi-purpose rooms and natatoriums. Conduit type for this application to be GRS or IMC in accordance with Article 300.4 of the National Electrical Code. Vertical drops from the roof deck shall be EMT and be routed along and attached to the structural steel.
12. All exposed raceways installed in a finished space will be painted to match the background, unless noted otherwise. Finished spaces include all areas open to the general public. Spaces such as storage, mechanical, IT, and electrical rooms and other similar areas only accessible to qualified personnel are considered unfinished.
13. All penetrations through not rated walls shall be sealed for draft stopping with caulk, putty, etc. designed for this use.
14. Fire / Smoke seals:
  - a. All penetrations through fire rated walls and floors shall be fire sealed in accordance with ASTM E814/UL1479 or manufacturer's recommendations.
  - b. Materials and installation details shall be submitted for approval.

**B. Electrical Metallic (EMT) Conduit**

1. EMT conduit shall be installed for all work concealed in partitions or in concrete block walls and for all conduits run in ceiling plenums and exposed runs, except where noted

otherwise. EMT conduit shall not be used outdoors, in wet locations, in floor crawl spaces, or below 5' AFF.

2. **EMT couplings and connectors shall be steel, set screw or compression type.**

C. Galvanized Rigid Steel (GRS) Conduit

1. Galvanized rigid steel conduits shall be installed for all exposed outdoor conduit, and for all indoor medium voltage cable runs, and for entry into underground building walls and manholes.
2. All GRS couplings and threaded hubs shall have no less than five threads of the coupling engaged. Running threads shall not be used. All GRS conduits shall be reamed.
3. All GRS conduits shall have two locknuts and a bushing at each termination outlet box, junction box, etc., except where terminated in a threaded hub.
4. GRS conduit shall be installed where underground conduits and duct banks enter through building foundation, tunnel walls, and drilled holes in manhole walls. The heavy wall conduit shall enter through core drilled holes and the annular space between the conduit and wall sealed using Thunderline Corp. "Link-Seal" Catalog No. 10-LS-300-C seals. This catalog number is for a 4 inch heavy wall steel conduit and requires a 6 inch I.D. core drilled hole. Refer to the manufacturer's installation requirements prior to drilling holes and for other conduit sizes. Seals as manufactured by Innerlynx Model C and Flexicraft Type E are acceptable equivalents.

D. Rigid Aluminum Conduit

1. Rigid aluminum conduits shall be installed for all exterior conduits supplying cooling towers.

E. Polyvinyl Chloride (PVC) Conduit

1. Conduits installed underground shall be schedule 40 PVC and a minimum size of  $\frac{3}{4}$ " trade size. PVC conduits may be installed in concrete floor slabs, and shall be a minimum of  $\frac{3}{4}$ " trade size. Rigid galvanized steel elbows shall be used for all stub-ups through or out of concrete slabs or through underground wall penetrations.
2. All PVC fittings shall be connected with PVC primer and glue.
3. Schedule 80 PVC shall be installed for all exposed conduit in pool and spa equipment rooms.

F. Metal Clad (MC) Cable

1. Type MC cable is permitted for wiring the final portion of light fixture branch circuits from fixture to fixture within a room or area. The MC cable may be supported by the light fixture bracing wires but shall not be supported by the ceiling grid support wires. Type MC cable is permitted for wiring from local distribution junction boxes to devices or equipment in nearby walls or ceiling space. The local distribution junction boxes should be located within 20 feet of the device or equipment served. Conduit and wiring shall be used for branch circuiting between the local distribution junction boxes and for the "homeruns" from the panels. Type MC cable is permitted to route from receptacle to receptacle through walls and through the ceiling space for the final portion of branch circuit wiring between



receptacles in adjacent walls of the same room or area. Type MC cable shall not be installed where exposed.

G. BX/AC Cable

1. **Type BX/AC cable is not permitted.**

H. Jacketed Flexible Steel Conduit

1. Jacketed flexible steel conduit ('Sealtite') shall be used in wet areas where flexible conduit connections are required and on all motorized equipment and motors in all locations.

I. Flexible Steel Conduit

1. Flexible steel conduit ('Greenfield') shall be used where vibration isolation is required, including all transformers and uninterruptible power systems.

J. High Density Polyethylene (HDPE)

1. Type HDPE Schedule 40 to be used for all directional boring applications. Provide UL listed coupling fitting where transitioning from HDPE to PVC/GRC.

K. PVC coated Galvanized Rigid Steel Conduit

1. PVC coated galvanized rigid steel conduits shall be installed for all exposed outdoor conduit.
2. All PVC coated GRS couplings and threaded hubs shall have no less than five threads of the coupling engaged. Running threads shall not be used. All PVC coated GRS conduits shall be reamed.
3. All PVC coated GRS conduits shall have two locknuts and a bushing at each termination outlet box, junction box, etc., except where terminated in a threaded hub.
4. Patch all damaged areas of coating protection upon completion of installation.

L. MI Cable

1. Install where indicated on drawings for fire pump installations for a minimum 2-hour fire rating cable assembly.
2. Prior to installation, provide catalog data demonstrating that MI cable to be used is listed as an electrical circuit protective system with a minimum 2-hour fire rating in accordance with UL 1724.

26.05.34 BOXES FOR ELECTRICAL SYSTEMS

A. Outlet Boxes, Junction Boxes, Fittings

1. Mounting: Outlets must be centered with regard to paneling, furring, trim, etc. Outlets shall be set plumb or horizontal and shall extend to finished surface of wall, ceiling, or floor

- without projecting beyond or behind finished surface. Outlet boxes shall not be installed "back-to-back".
2. Attaching: Boxes shall be attached by fastener designed for the purpose and shall provide adequate mechanical strength for future maintenance.
    - a. Boxes installed in metal stud partitions shall be secured to the metal studs using appropriate clips, fasteners, hangers, or supports as required, and shall provide adequate far side box support to fulfill the intent of all applicable codes.
  3. Pull boxes and junction boxes shall be installed where indicated on the drawings or where required to facilitate wire installation.
    - a. Size: Outlet, junction, and pull boxes not dimensioned shall be 4 inch square by 2-1/8" deep minimum and comply with sizing as required by Article 314 of the National Electrical Code.
  4. In fire rated drywall walls, 24" spacing must be maintained between boxes on opposite sides of walls. Moldable fire protective putty pads, firestopping coverplate gaskets, internal fire rated pads or other acceptable fire sealing means shall be installed on outlet boxes where the 24" spacing cannot be maintained.
  5. Steel faceplates must be used on fire rated drywall walls and painted to match device color. Faceplates shall be Mulberry Metal Products or equivalent.
  6. All outdoor junction boxes and condulets shall be gasketed.

#### 26 05 48 SEISMIC RESTRAINT

- A. All materials and workmanship shall specifically comply with the above listed Building Code with respect to seismic requirements for the support and anchorage of all electrical, communications and electronic safety and security systems and equipment as installed on this project. Lateral forces to be restrained shall be as required by IBC Section 1621 Architectural, Mechanical, and Electrical Component Seismic Design Requirements and ASCE 7-02 Section 9.6 Architectural, Mechanical, and Electrical Components and Systems with the following design parameters:

Site Class as Defined in the IBC: **C**.  
Assigned Seismic Use Group or Building Category as Defined in the IBC: **III**.
- C. All conduit support and restraint details and practices shall conform to the publication "Seismic Restraint Systems Guidelines" by Cooper B-line-TOLCO.
- D. Seismic restraint submittals shall be provided for engineer review and include, but not be limited to, detailed drawings showing seismic restraint types, anchor type and attachment details, calculations and spacing requirements of unique equipment and conduit for this specific project. Submittals shall include floor plan drawings indicating equipment, ductwork and piping to be restrained, restraint locations and restraint component types. All submittals and floor plan drawings shall bear the seal of a licensed structural engineer of the State of Missouri.

26 05 73 ARC FLASH HAZARD ANALYSIS, SHORT CIRCUIT AND SELECTIVE COORDINATION

- A. The contractor shall furnish an Arc Flash Hazard Analysis Study for all new distribution equipment installed per the scope of this project downstream of both 'MDP1' and 'DPLP3', including but not limited to control panels, starters, disconnects, etc. per the requirements set forth in the current version of NFPA 70E. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 – 2002.
- B. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer, licensed in the State of Missouri, and skilled in performing and interpreting the power system studies.
- C. The studies shall be performed using the latest version of SKM Systems Analysis PowerTools for Windows (PTW) software program.
- D. Short Circuit Analysis:
  - 1. Transformer design impedances shall be used when test impedances are not available.
  - 2. Provide the following:
    - a. Calculation methods and assumptions
    - b. Selected base per unit quantities
    - c. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis. Labeling of components shall match the one-line and floorplans.
    - d. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions greater than 5HP, and other circuit information as related to the short-circuit calculations.
    - e. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.
    - f. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
  - 3. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.
- E. Protective Device Coordination Analysis:
  - 1. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.
  - 2. Include on each TCC graph, a complete title with descriptive device names.

3. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
4. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
5. Plot the following characteristics on the TCC graphs, where applicable:
  - a. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
  - b. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
  - c. Transformer full-load current, magnetizing inrush current, inrush/full load current multiplier, and ANSI through-fault protection curves
  - d. Medium voltage conductor damage curves
  - e. Ground fault protective devices, as applicable
  - f. Pertinent motor starting characteristics and motor damage points, where applicable
  - g. The largest feeder circuit breaker in each motor control center and applicable panelboard.
6. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.
7. Final overcurrent device settings as identified by the protective device coordination study shall be implemented by the installing contractor.

F. Arc Flash Hazard Analysis:

1. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in the latest version of NFPA70E, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis and the protective device time-current coordination analysis.
2. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
3. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.
4. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
5. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must

be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.

6. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
7. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
  8. Fault contribution from induction motors should not be considered beyond 5 cycles.
  9. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.
10. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
11. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
12. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

G. Submittal:

1. The results of studies shall be summarized in a final report. Electronic PDF copies of the report shall be provided. The report shall include:
  - a. A One-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
  - b. Log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

- c. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses.
- d. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, minimum personal-protective equipment AFIE rating and AFIE (Arc Flash Incident Energy) levels.
- e. Arc Flash Labels shall be furnished and installed in accordance with NFPA 70E and all applicable local codes and standards.
- f. Notify the engineer in writing, of any circuit protective devices improperly rated for the calculated available fault current, of any significant deficiencies in protection and/or coordination and of any significant deficiencies in protection and/or coordination.
- g. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram.

## **26 20 00 LOW-VOLTAGE ELECTRICAL TRANSMISSION**

### **A. SHORT CIRCUIT RATINGS**

1. All short circuit ratings shall be Fully Rated device ratings, not Series Rated.

## 26 24 00 SWITCHBOARDS AND PANELBOARDS

### 26 24 13 MAIN SWITCHBOARD

- A. Fusible switches or circuit breakers shall be provided in the sizes and arrangements shown on the drawings. Provide a 3" wide x 1" high phenolic nameplate for each switch/breaker as follows:

<b>EQUIPMENT IDENTIFICATION</b>	<b>(3/8" Lettering)</b>
<b>__AS/ __AF</b>	<b>(XX AMP SWITCH/XX AMP FUSE)</b>
	<b>(1/4" Lettering)</b>

- B. Manufacturer: The main switchboard will be a Type QED1 manufactured by Square D.

### 26 24 16 PANELBOARDS

#### A. DISTRIBUTION PANELBOARDS:

1. Fusible Switches and Circuit Breakers: Fusible switches and circuit breakers shall be provided in the sizes and arrangements shown on the drawings. Fusible switches shall accept Class R fuses. Provide a 3" wide x 1" high phenolic nameplate for each switch as follows:

<b>EQUIPMENT IDENTIFICATION</b>	<b>(3/8" Lettering)</b>
<b>__AS/ __AF</b>	<b>(XX AMP SWITCH/XX AMP FUSE)</b>
	<b>(1/4" Lettering)</b>

- a. The switches shall be provided with a door interlock to prevent access to fuses and switch when energized and manually operated interlock defeat mechanism. The door is to be furnished with "on-off" handle position markings and a means to lock the switch in the open position is to be provided.

2. Manufacturer: The panelboard shall be manufactured by Square D.
3. Refer to Section 20 00 72 for support of equipment and "housekeeping pad" requirements.

#### B. CIRCUIT BREAKER PANELBOARDS

1. Panels shall be dead front, safety type, furnished with branch circuit protecting devices, equipment grounding bus, phenolic nameplate, main bus and cable lugs factory assembled, with all components in place, ready for installation. Contractor to determine top or bottom feed for lug placement. Feed locations **shall not** be reviewed by the Engineer.
2. The circuit breakers shall be of the molded case, bolt-on type suitable for voltage and ampere ratings indicated on drawings and in schedules and shall have a minimum interrupting capacity of 10,000 amperes (120/208V) or 14,000 amperes (277/480V) or as noted on the drawings.
3. Buses and connectors shall be silver or tin plated hard drawn copper of 98% conductivity, with current carrying capacity to maintain established rise tests as defined in UL Standard UL 67.
4. A directory frame shall be attached to inside face of hinged door. The directory card shall be neatly typed to identify circuits. A transparent plastic facing shall protect the directory card. Room numbers shall be included in directory descriptions. Furnish a copy of each



panel directory to the Architect/Engineer. **Where existing panelboard loads are modified, the panel directories shall be updated.**

5. All flush mounted panelboards shall have spare 1" conduits stubbed up out of the panelboard and extended to above an accessible ceiling. Panelboards in interior wall shall have two conduits stubbed out on both sides of the wall (four conduits total). Panelboards in exterior walls shall have three conduits stubbed out into the building interior.
6. Panelboards to be by Square D Corporation.

**26 27 00      LOW-VOLTAGE DISTRIBUTION EQUIPMENT**

26 27 26      WIRING DEVICES

A. General: Furnish and install wiring devices as scheduled in Table 1 below, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA and FedSpec standards.

1. Provide ivory color devices and nylon wall plates except as otherwise indicated.
2. Provide devices in colors as follows:

<b>Space:</b>	<b>Device:</b>	<b>Coverplate:</b>
<b>Offices</b>	<b>Ivory</b>	<b>Ivory Nylon</b>
<b>Conference Rooms</b>	<b>Ivory</b>	<b>Ivory Nylon</b>
<b>Restrooms</b>	<b>Ivory</b>	<b>Ivory Nylon</b>
<b>Corridors</b>	<b>Ivory</b>	<b>Ivory Nylon</b>
<b>Emergency</b>	<b>Red</b>	<b>Red</b>

3. Modular Wiring versions of the wiring devices in Table 1 are permitted. (Hubbell SNAPConnect, Leviton Lev-Lok, Cooper ArrowLink, or P&S PlugTail)

B. Listings and Standards:

Switches - UL20, FedSpec WS896-E  
Receptacles - UL948, FedSpec WC-596F, NEMA WD-1 and WD-6  
GFI – UL943

TABLE NO. 1

DEVICES

<u>Receptacles</u>	<u>Hubbell</u>	<u>Leviton</u>	<u>Cooper</u>	<u>P &amp; S</u>
20A Duplex	HBL5362-I	5362A-I	5362V	5362A-I
20A GFI	GF20IL	7899-I	VGf20V	2095-I
20A Duplex w/ USB			TR7746	
Recessed Clock				
Outlet	---	688-I	TR775W-BOX	
<u>Switches</u>				
20A Single	1221I	1221-2I	AH2221V	PS20ACI-I
20A 3-way	1223I	1223-2I	AH2223V	PS20AC3-I
20A 4-way	1224I	1224-2I	AH2224V	PS20AC4-I
20A 2 pole	1222I	1222-2I	AH2222V	PS20AC2-I
20A Momentary				
SPDT	HBL1557-I	1257-I	1995V	PS1251-I
20A Pilot Light	HBL1221PL/PL7	1221-PLR/7PR	2221PL	PS20ACI-RPL
<u>Nylon Plates</u>				
Duplex	NP8I	80703-I	5132V	TP8-I
Quadplex	NP82I	80716-I	5150V	TP82-I
Single Toggle	NP1I	80701-I	5134V	TP1-I
2-Gang Toggle	NP2I	80709-I	5139V	TP2-I
GFI	NP26I	80401-N1	5151V	TP26-I
<u>Weatherproof Plates</u>				
WP GFI	NWP26	6196-V	1966	WP26-I
WP In Use GFI	Bell MX4280	(Z-bronze, WH-white, S-gray)		
<u>Locking Plates</u>				
Single Gang	FSR WB-MS1G			
Two-Gang	FSR WB-MS2G			
Three-Gang	FSR WB-MS3G			
Four-Gang	FSR WB-MS4G			

- E. All receptacles shall be identified with a black-on-clear printed adhesive label affixed to the coverplate. This label shall include the panel and branch circuit number supplying power to the receptacle.

## **26 28 00      LOW-VOLTAGE CIRCUIT PROTECTIVE DEVICES**

### 26 28 13      FUSES

- A. Electrical Contractor shall furnish and install a complete set of fuses as manufactured by the Bussmann Company or Mersen Electrical Power (Ferraz Shawmut), sized for ordinary service of motors and other loads served and at each safety switch installed as shown on the drawings and as hereinafter specified.
- B. Fuses for motor loads and all other loads up to 600 A and up to 600 V shall be Buss "Low-Peak" or Mersen Amptrap 2000 dual element fuses, having a minimum interrupting capacity of 200,000 A RMS symmetrical. The fuses shall be UL Class RK1.
- C. Fuses for all loads above 600 A and up to 600 V shall be Buss "Low-Peak" or Ferraz Mersen Amptrap 2000 current limiting, time delay fuses, with a minimum interrupting capacity of 200,000 A RMS symmetrical. The fuses shall be UL Class L.
- D. The installation of fuses of mixed manufacturers shall not be accepted. Fuse of only one manufacturer shall be installed.
- E. Upon completion of the building construction, the Contractor shall provide a complete set of three spare fuses for each size and type used.

### 26 28 16      DISCONNECT SWITCHES

- A. Type of Switch: Furnish and install disconnect switches as specified where shown on the drawings.
  - 1. All disconnect switches shall be classed Heavy Duty and enclosed as required by NEMA Standards. Switch sizes and fusing shall be as shown on the drawings.
  - 2. Switch shall have a quick make, quick break mechanism operating through the box and not the cover. The switchblades shall be visible when the hinged door is open.
  - 3. The cover shall be interlocked with the operating handle to prevent opening door when switch is "ON" and a means provided to lock switch in the "OFF" position. This mechanism shall be capable of being defeated.
  - 4. Provide a 4" wide x 1½" high phenolic nameplate reading the following for each switch:

<b>'EQUIPMENT IDENTIFICATION'</b>	<b>(3/8" Lettering)</b>
<b>SERVICE DISCONNECT</b>	<b>(3/8" Lettering)</b>
<b>FED FROM 'SOURCE NAME'</b>	<b>(1/4" Lettering)</b>
<b>LOCATE IN 'SOURCE LOCATION'</b>	<b>(1/4" Lettering)</b>
- B. Manufacturer: Switches shall be by Siemens, Square D, Eaton Cutler Hammer, or General Electric by ABB.

## **26 29 00            LOW-VOLTAGE CONTROLLERS**

### **A. CONTROL AND INTERLOCK WIRING**

1. The Electrical Contractor shall furnish and install control and interlock wiring as shown on the electrical drawings. Control and interlock wiring required by Division 22 or 25 but not shown on the electrical drawing shall be the responsibility of the Division 22 or 25 Contractor requiring the wiring.
2. Generally this will mean that Division 26 wires the series safety circuit to the magnetic starters, furnished with Hand-Off-Auto selector switches, using switches and devices furnished by the Mechanical Contractor.
3. Starter automation, as required by the temperature control sequence of operation, will be provided and wired by Division 22 or 25 with connections made to terminals on the automatic side of the selector switch and on starter coil auxiliary contacts.
4. The intention is that Division 26 furnish and install all wiring necessary to operate the magnetic starters with the selector switch in the Hand position and that Division 22 or 25 provide all additional automation required.
5. Relays, electropneumatic relays, and any other device required by Division 22 or 25 to operate in parallel with the starter coil shall be controlled through spare auxiliary contacts on the starter furnished by Division 26 and shall not be connected to the starter coil.
6. Single-phase motors generally are controlled by line voltage controllers furnished by the Temperature Control Contractor but installed by the Electrical Contractor. If the control sequence is more complicated than a single line voltage device such as a unit mounted thermostat, a relay or control device with a horsepower rated contact will be provided by the Temperature Control Contractor for installation by the Electrical Contractor adjacent to the motor disconnect device. The Electrical Contractor shall provide power-wiring connections to this control device. Temperature Control Contractor will provide control and interlock wiring to this control device.

### **26 29 13    MOTOR AND APPLIANCE CONTROL**

- A. Electrical Contractor shall furnish and install all electrical devices incident to the work except as otherwise stated herein. The Mechanical Contractor will furnish prewired control panels for equipment so indicated on the plans and will furnish EP switches, electrical thermostats, pressure switches and other temperature control devices as required by the specific sequence of operation for installation by the Electrical Contractor. Others will do testing and adjusting of mechanical system devices.
- B. The motor and appliance control devices shall be as follows:
  1. All starters shall be installed in NEMA 1 Enclosure unless noted otherwise on the drawings. Where noted other than NEMA 1, furnish the indicated NEMA rated enclosure.
  2. Single Phase Magnetic Starters - Square D Class 8536 with one overload, 120 volt coil, N.O. auxiliary contacts, heavy-duty 30 mm and hand-off-automatic selector switch in cover all in an oversized NEMA enclosure.
  3. Three Phase Manual Starters - Square D Class 2510 Type M, push button operated, lock-out guard, three thermal overloads in a NEMA enclosure. Furnish with or without pilot light and auxiliary contacts as indicated on drawings.

4. Three Phase Magnetic Starters - Square D Class 8536 with three overloads, 120 volt control transformer with 2 primary and 1 secondary fuses, heavy-duty 30 mm, hand-off-automatic selector switch, heavy-duty 30 mm pilot light, and extra N.O. auxiliary contacts all in a NEMA enclosure.
5. Three Phase Combination Starter and Fusible Disconnect Switch - Square D Class 8538 with a NEMA enclosure including a three pole fusible switch and a starter with three overloads, 120 volt control transformer with 2 primary and 1 secondary fuses, heavy-duty 30 mm, hand- off-automatic selector switch and heavy-duty 30 mm pilot light and N.O. auxiliary contacts.
6. Fractional HP Single Phase Manual Starters - Square D Class 2510 Type F, toggle switch operated with lock-out guard, single thermal overload. Furnish starters single speed with or without pilot lights as indicated on the drawings. All surface mounted starters shall be mounted in a 'FS' conduit box.
7. Integral HP Single Phase Manual Starters – Square D Class 2510 Type M, push button operated, lock-out guard, single thermal overload in NEMA enclosure. Furnish with or without pilot light and auxiliary contacts as indicated on drawings.
8. Selector Switches and Pushbutton Stations - Square D Class 9001 heavy duty 30 mm in NEMA enclosure.
9. Provide a 3" wide x 1½" high phenolic nameplate reading the following for each motor starter:

<b>EQUIPMENT IDENTIFICATION</b>	<b>(3/8" Lettering)</b>
<b>Size ' _', __A Overload</b>	<b>(1/4" Lettering)</b>
<b>FED FROM _____</b>	<b>(1/4" Lettering)</b>

10. Relays - Square D Class 8501 with 120 volt coil in NEMA 1 enclosure. Furnish with number of poles indicated on the plans.
11. Provide a phenolic nameplate for each motor starter.
12. Devices of similar construction and design as manufactured by Eaton Cutler Hammer, Allen Bradley, Siemens, or General Electric by ABB are also acceptable.

#### 26 29 23 VARIABLE FREQUENCY DRIVES

- A. The Electrical Contractor shall provide variable frequency drives as shown on the drawings. The Electrical Contractor shall furnish and install the controller, control devices, and interconnection wiring as specified below.
- B. Drive General Description:
  1. Furnish and install variable frequency drives as specified herein. The assembly shall include a circuit breaker or input fuses, motor overload relay(s) and operational options required by this specification.
  2. A factory authorized trained technician shall make final adjustments and settings on the drives and shall submit a field report to the Engineer stating the setpoints and ramp time settings on each drive.
- C. Drive Components:

1. The variable frequency drive system shall include a diode bridge rectifier, DC link reactor for reduction of harmonics, capacitor filter, and IGBT inverter section. The output shall be capable of a 12khz sine-coded pulse width modulated output for quiet operation. The drive ratings shall be based upon 8khz output.
2. Refer to Mechanical Electrical Interface for maximum carrier frequency rating.
3. The controller shall include the following devices:

Drive manual on-off-auto selector switch to manually energize or de-energize the drive control system.

Manual speed selector to allow a specified speed to be selected and maintained if the manual-off-automatic selector switch is in the manual position.

Integral line side circuit breaker.

4-20 milliamp output that is directly proportional to drive speed.

4. Provide a 3" wide x 1" high phenolic nameplate for each starter or disconnect as follows:

<b>EQUIPMENT IDENTIFICATION</b>	<b>(3/8" Lettering)</b>
<b>__AS/__AF (XX AMP SWITCH/XX AMP FUSE)</b>	<b>(1/4" Lettering)</b>

or

<b>EQUIPMENT IDENTIFICATION</b>	<b>(3/8" Lettering)</b>
<b>Size ' _ ', __A Overload</b>	<b>(1/4" Lettering)</b>

5. The system protection as a minimum will provide the following:
  - a. Overcurrent protection of 100% continuous, 110% for 1 minute.
  - b. Instantaneous overcurrent trip at 150%.
  - c. Current limit stall prevention shall be adjustable 10 to 110%.
  - d. Ground fault protection.
  - e. Current limiting DC bus fuse.
  - f. Overvoltage protection.
  - g. Undervoltage protection.
6. When the drive faults, the drive shall activate a 1NO, 1NC-fault relay display for indication of type of trip.

OC:	Overcurrent trip at 150%
OCA:	Overcurrent on start-up
OCL:	Overcurrent on output
OL:	Overload
OP:	Overvoltage due to power surge
OP2:	Overvoltage while deceleration
POFF:	Undervoltage
OH:	Overheat
EF:	Ground faults

7. Auto restart shall be a standard feature of the drive as follows:

Auto restart enabled or disabled by jumper or keypad selection.

If auto restart is selected the microprocessor shall determine, in the event of a fault, if a restart should be attempted. A restart will be attempted under the following condition:

Undervoltage (UP) - Every time as soon as voltage returns to a safe level. Fault relay is not activated.

Input Overvoltage (OPS) and DC Bus Overvoltage (OP) - Every time if voltage returns to normal within 30 seconds, fault relay is not activated.

Overcurrent (OC) - Drive delays 1 second and attempts a restart. If drive trips a second time it delays 2 seconds and attempts a second restart. Overall, five attempts are made after successive delays of 1, 2, 4, 8 and 16 seconds. If the restart fails the drive locks out and sets the fault relay on. (Number of restarts and time delays to be adjustable via keypad or jumpers).

A restart will not be attempted for any other type of fault and the drive will trip out immediately, activate the fault relay and make the appropriate indication on the display.

8. In the event of a fault trip the microprocessor shall save the status of the drive at the time of the fault and make that information available on the display until the drive is reset or the control power is removed.
9. An undervoltage condition of less than 100 ms duration shall not affect drive operation. If main power falls below 85% of rated voltage for longer than 100 ms while control power is retained the drive shall forcibly decelerate the load in an attempt to force a higher bus voltage through regeneration. This feature, depending on the inertia of the load, shall allow the drive to "ride through" a longer condition.
10. A minimum of 3% DC link or line reactor.
11. Operation functions shall include the following:

Acceleration and deceleration time independently adjustable from .1 to 1200 seconds.

Signal follower 0-5VDC, 0-10VDC, 4-20ma, 0-20ma, 1- 5VDC, or 0-135 ohms selectable. An increasing input signal can command increasing or decreasing frequency as required by the application.

Ramp to stop or coast to stop for normal operation (coast to stop on fault). Volts/Hertz patterns selectable by keypad.

Upper and lower frequency limit adjustments shall be available. When the drive reaches one of the limits it shall activate an open collector signal available to the user. A dry contact signal shall be available as an option.

12. Drives shall have a Short Circuit Current Rating (SCCR) of 100,000 amps.

- D. The following catalog data shall be submitted for the controller:

Dimensioned drawings.  
Operation and installation manuals.

Maintenance, adjustment, part breakdown and troubleshooting manual.



Connection diagrams.

Schematic diagrams including printed circuit boards, wiring harnesses, and enclosure mounted controls.

- E. Drives shall be furnished with BACNET and MODBUS Network Cards factory installed.**
- F. Refer to Section 26 00 72 for support of equipment and “housekeeping pad requirements”.
- G. Variable frequency drives shall be Toshiba Q9 Plus or AS3, YASKAWA HV600, or ABB ACH 580.

END OF SECTION  
071588.002

Appendix A  
2003 Dectron Shop Drawings



The Total Engineered Solution

# FINAL RE-SUBMITTAL

For Approval  
RJ03-509

**PROJECT:** Brewer Fieldhouse  
Columbia, MO

**ARCHITECT:** Hastings & Chivetta

**ENGINEER:** McClure Engineering  
Keith Esarey & Don Eschelbach

- APPROVED       NOT APPROVED
- APPROVED AS CORRECTED
- REVISE AND RESUBMIT

**CONTRACTOR:** J. Louis Crum Corp  
Don Fritz

**EQUIPMENT:** Dectron

These documents were prepared with the understanding that they would be subject to review and approval by the contractor and architect. The contractor shall be responsible for the accuracy in all respects of the information provided in the contract documents. The contractor shall be responsible for the information given in the contract documents. The contractor is responsible for the accuracy of the information that is provided in the contract documents. The contractor shall be responsible for the accuracy of the information that is provided in the contract documents. The contractor shall be responsible for the accuracy of the information that is provided in the contract documents.

BY DOE  
DATE 10/27/03

McClure Engineering & Architecture  
CONSULTING ENGINEERS  
ST. LOUIS, MISSOURI

**DATE:** October 27, 2003

**PREPARED BY:**  
Chuck Ruedebusch  
800-444-8470ext220  
Fax 800-887-6885

# DRY-O-TRON®

## Load Summary and DRY-O-TRON® Selection

10/16/2003

Project: U of MO Aquatic Center Club Pool  
 Room Temperature: 85 °F DB  
 Relative Humidity Range: Active : 59 % Unoccupied : 50 %  
 Active Hours: 14  
 Outdoor Conditions for: Columbia, MO  
 Summer Design: 95 °F DB 75 °F WB  
 Winter Design: -1 °F DB

Prepared by: Michael Keller B.Sc. E. Eng.

Load Source	Load lb/h		Design Criteria			Primary Water Heater
	Active	Inactive				
Pool #1 (Leisure Pool)	114.6	67.3	1985 sq ft	87 °F	1	Dry-O-Tron
Pool #2 (Lazy River)	59.6	26.9	794 sq ft	87 °F	1.3	Dry-O-Tron
Pool #3 (Vortex)	60.10	23.50	694 sq ft	87 °F	1.5	Dry-O-Tron
Pool #4 (Grotto & Water Fall)	44.5	17.4	514 sq ft	87 °F	1.5	Dry-O-Tron
Pool #5 (Whirlpool/Spa)	47.3	25.3	323 sq ft	104 °F	1	By Others
Outdoor Air	-44.4			8800 CFM		N/A
Spectators	68.7			335@.205		N/A
Total Dehumidification load	350.4	160.5				

DRY-O-TRON® SELECTION Standard Unit DS-282-SS && Purge Design Day Run time: 73%

### Air Cooled Condenser Auxiliary Heat Rejection & System Charge

Air on condenser: 100

Total heat rejection required: 966200 btu/h

Condenser Model	Voltage	MCA	Fuse/MOP	Qty of Fans	HP/Fan	Weight (lbs)	RPM
CID068	460/3/60	12.8	15	4	1.50	1934	1140

Total line length between outdoor air cooled condenser and the DRY-O-TRON (ft): 75

The condenser is: 30 ft Above the DRY-O-TRON  
 Line sizes to the condenser:  
 Standard Unit 1 5/8 Hot gas 1 3/8 Liquid  
 1 5/8 Hot gas 1 3/8 Liquid

Refrigerant type: R-22 Standard Unit  
 Factory Charge (lbs): 325  
 System Charge (lbs): 730  
 Field Charge by installing contractor (lbs): 405

### Notes:

- 1) Ensure there is clearance around the perimeter of the condenser equal to its width
- 2) Do not deviate from the recommended line sizes to the outdoor condenser.
- 3) Multiple fan units have ambient thermostat (factory supplied) controlled fan cycling kits.
- 4) Contactor and 24 volt transformer included.
- 5) Ensure traps are installed at all elevation changes and every 20' of riser.
- 6) A separate power supply is required to the outdoor air cooled condenser.
- 7) Disconnect by others

Software version: 2.0.1

USA 10935 Crabapple Road Suite202B Roswell, GA 30075 Tel: (770) 649-0102 Fax: (770) 649-0243  
 Canada 4300 Poirier Blvd., Montreal, QC H4R 2C5 Tel: (514) 334-9609 Fax: (514) 334-9184

PAU-1 Winter SS Performance Oct 21 2003

PAU-1

OA

PRG:cWATERH \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-22-2003  
- RATING -  
CFM 8800 INSIDE COEFF(Hi) = 546.2  
EDB -1.00 OUTSIDE COEFF(Ho) = 17.7  
LDB 47.85  
- - THERMAL COND(k) = 0.273  
SENS HT 466235 VIS(CENTIPOISE) = 3.39  
EWT/LWT 56.9 / 46.6 SP. HEAT = 0.86  
GPM 100.0 FREEZE POINT = -2.9 DENSITY = 65.46  
WV 5.1 REYNOLDS NUMBER = 6088  
FPD,PSI 6.2 HT.TRANSFER RATE = 11.64  
NO. CIR 32 LOG MEAN TEMP = 23.24  
FV 586.7 FPI = 10  
APD 0.80 ROW = 6  
FH = 40.000 FL = 54.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 15.00 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 32 - 6 - 10 - 54.0 CONN. SIZE = 2.625

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410\*\*\*

Print this screen? (Y/N) > N

EA

PRG:cWATERC \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-22-2003  
- RATING -  
CFM 9700 INSIDE COEFF(Hi) = 471.6  
EDB/EWB 85.0 / 72.4 OUTSIDE COEFF(Ho) = 15.9  
LDB/LWB 59.2 / 58.6 WET OUTSIDE COEFF(Ho) = 15.9  
MBH 463.79 THERMAL COND(k) = 0.273  
MSH 271.47 VIS(CENTIPOISE) = 3.45  
EWT/LWT 46.6 / 56.9 SP. HEAT = 0.86  
GPM 100.0 FREEZE POINT = -2.9 DENSITY = 65.47  
WV 5.1 REYNOLDS NUMBER = 6008  
FPD,PSI 9.3 HT.TRANSFER RATE = 10.45  
NO. CIR 32 LOG MEAN TEMP = 19.32  
FV 485.0 FPI = 10  
APD 0.77 ROW = 6  
FH = 80.000 FL = 36.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 20.00 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 64 - 6 - 10 - 36.0 CONN. SIZE = 2.625

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410 ; APPLIES WHEN EDB >=35 \*\*\*

Print this screen? (Y/N) >

# PAU-1



## Supply Fan @ 4.25" ESP (40 HP)

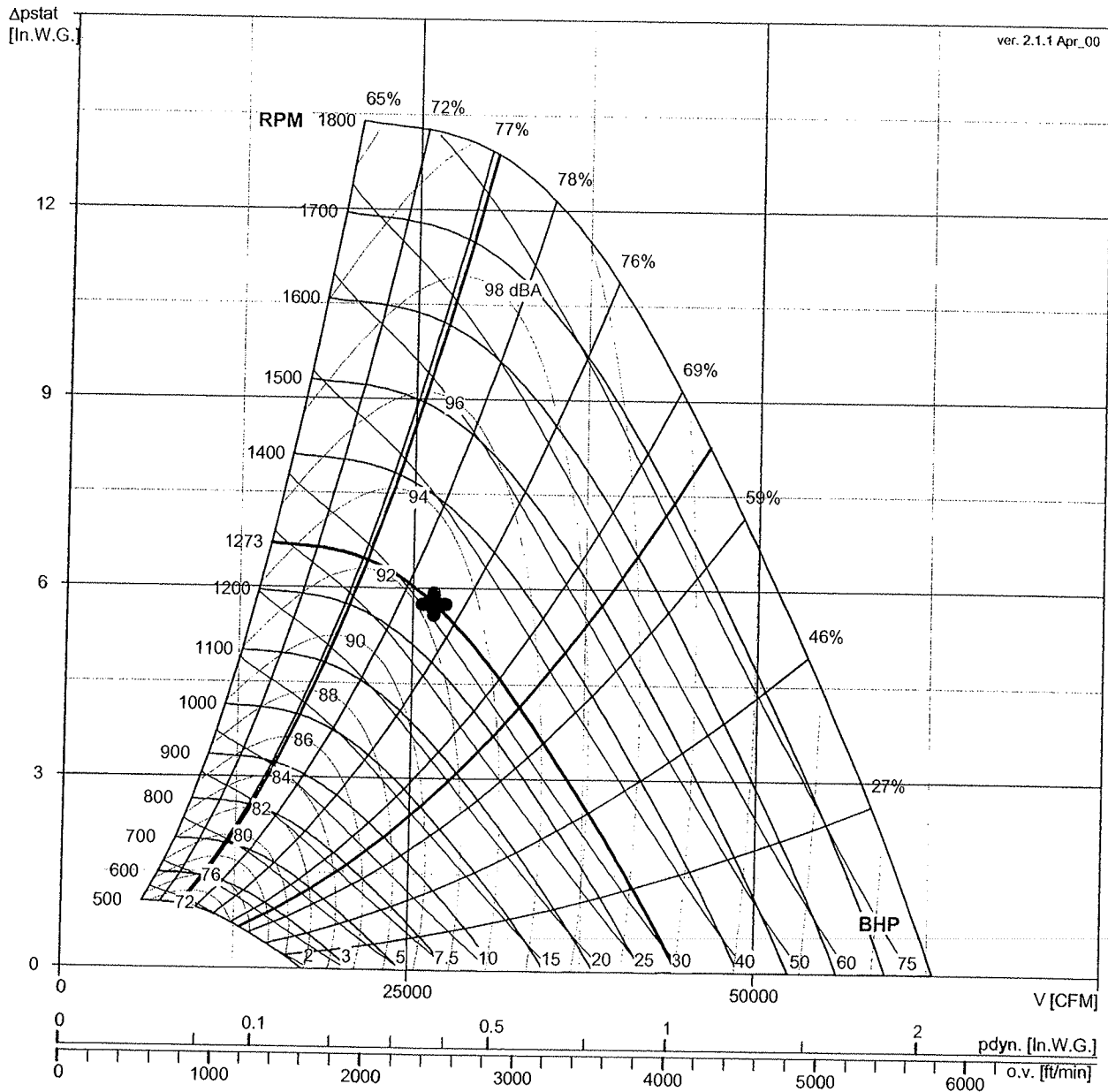
Model/size: ATZAF 32-32  
 Max fan rev.: 1700 RPM  
 Max. fan abs. BHP: 66.5 BHP  
 Moment of inertia: 232.00 lb ft<sup>2</sup>

**Fan working condition: Free inlet- Ducted outlet**  
 Volume: 26500 CFM  
 Stat. pressure: 5.75 In.W.G.  
 Abs. shaft fan BHP: 31.31 BHP  
 Stat. Efficiency: 76.8 %  
 Temperature: 68.0 °F  
 Elevation: 0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft

Fan plot condition: ATZAF 32-32 T2 Free inlet- Ducted outlet

LwA4;7: A-weighted Sound Power Level inside the fan outlet duct and at fan inlet.



Power rating (BHP) does not include drive losses  
 Performance ratings do not include the effects of appurtenances in the airstream.

# PAU-1



## ExFan#1 Min Exhaust @ 2.25" ESP (10 HP)

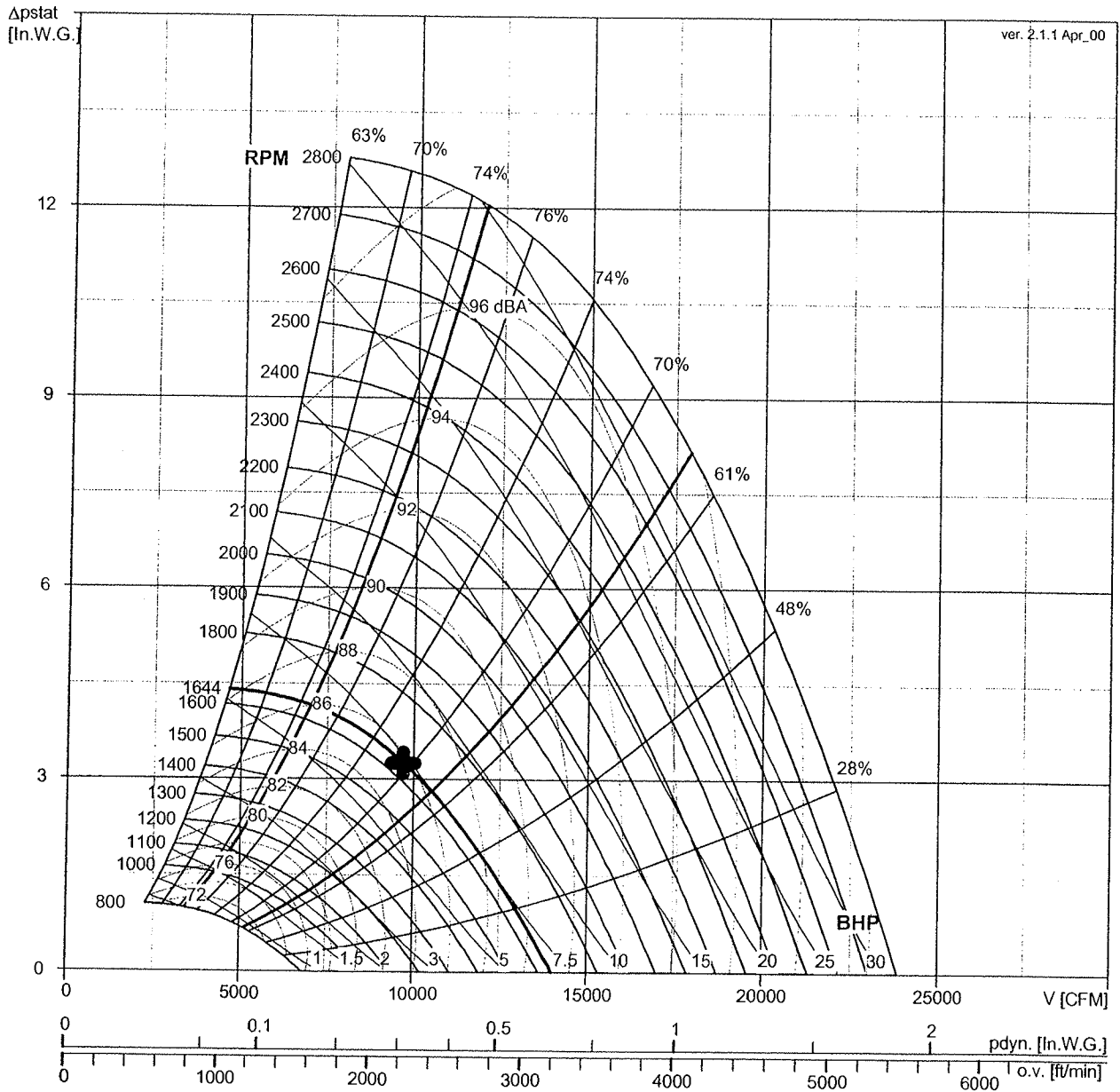
Model/size: ATZAF 20-20  
 Max fan rev.: 2750 RPM  
 Max. fan abs. BHP: 29.5 BHP  
 Moment of inertia: 32.00 lb ft<sup>2</sup>

**Fan working condition: Free inlet- Ducted outlet**  
 Volume: 9700 CFM  
 Stat. pressure: 3.25 In.W.G.  
 Abs. shaft fan BHP: 7.29 BHP  
 Stat. Efficiency: 68.3 %  
 Temperature: 68.0 °F  
 Elevation: 0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft

Fan plot condition: ATZAF 20-20 T2 Free inlet- Ducted outlet

LwA4;7: A-weighted Sound Power Level inside the fan outlet duct and at fan inlet.



Power rating (BHP) does not include drive losses  
 Performance ratings do not include the effects of appurtenances in the airstream.

3.04.01

# PAU-1



## ExFan#2 Purge @ 2.25" ESP (20 HP)

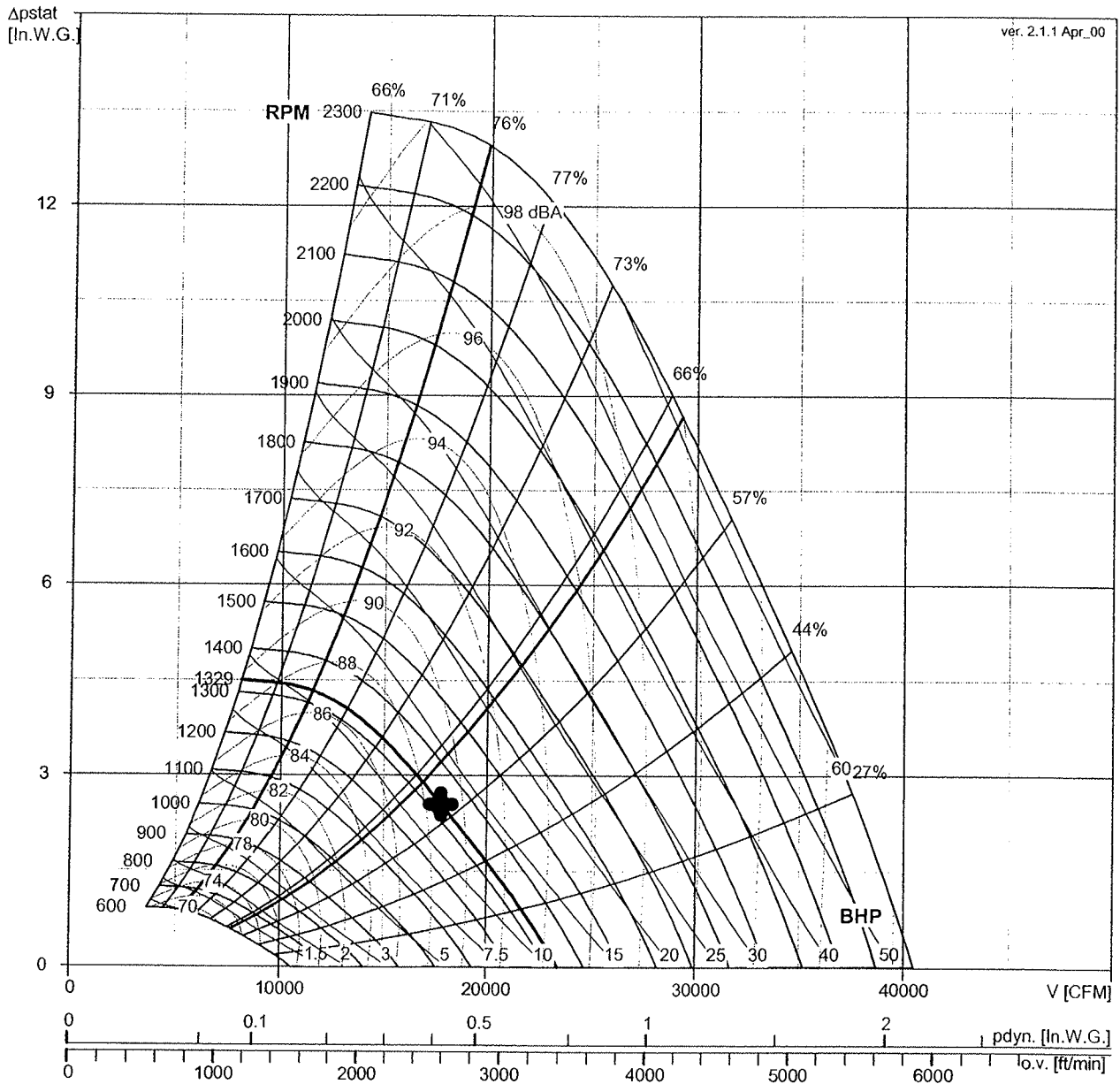
Model/size: ATZAF 25-25  
 Max fan rev.: 2200 RPM  
 Max. fan abs. BHP: 50.0 BHP  
 Moment of inertia: 82.80 lb ft²

**Fan working condition: Free inlet- Ducted outlet**  
 Volume: 17800 CFM  
 Stat. pressure: 2.55 In.W.G.  
 Abs. shaft fan BHP: 12.25 BHP  
 Stat. Efficiency: 58.5 %  
 Temperature: 68.0 °F  
 Elevation: 0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft

Fan plot condition: ATZAF 25-25 T2 Free inlet- Ducted outlet

LwA4;7: A-weighted Sound Power Level inside the fan outlet duct and at fan inlet.



Power rating (BHP) does not include drive losses  
 Performance ratings do not include the effects of appurtenances in the airstream.



# Dectron

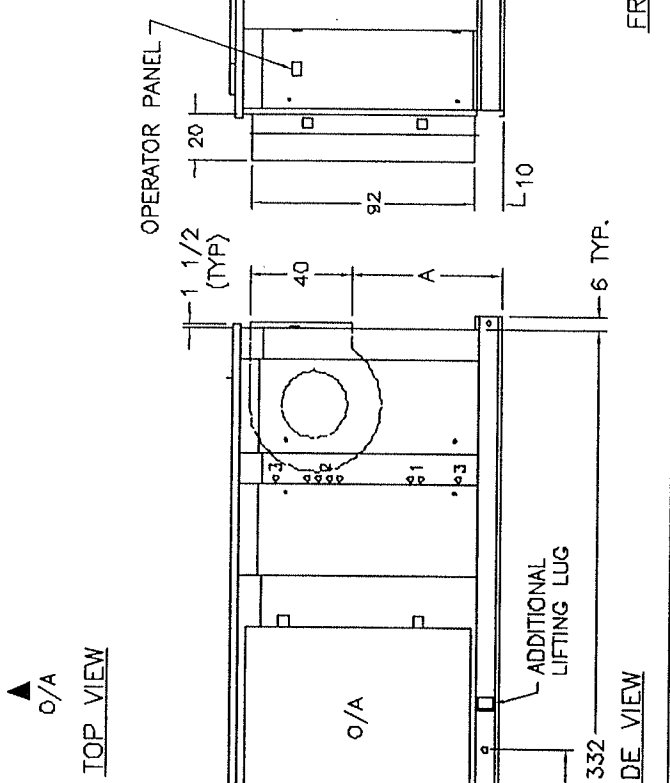
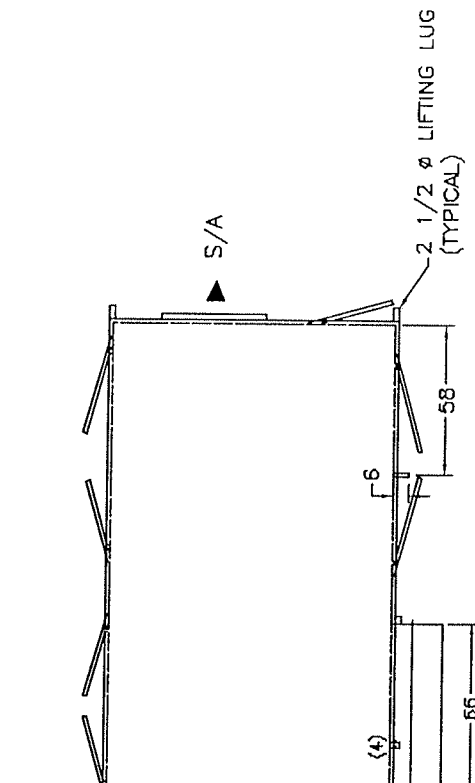
ELECTRO-TECH

NO. DESSIN: DS-NM-282-306 AE REV: 2  
 DWG. NO.:  
 TITRE: MODEL DS-282  
 H.A.D.(CW), R.S.A.R., L.S.D.A., T.E.A.  
 C/W SMART SAVER, PURGE  
 & SPRING ISOLATED SUPPLY FAN  
 NOTES: ALL DIMENSIONS ARE IN INCHES.

DRAWING DETAIL	
DESIGNER PAR: R.T.	
DRAWN BY: H.X.	DATE: 22 APR./03
VERIFÉ PAR: N.T.S.	CHECKÉ BY: PAU-1
ÉCHELLE: N.T.S.	APPROXIMATE WEIGHT: 20,000 lb. ±10%
POIDS APPROXIMATE:	

REVISION DETAIL		
NO:	DATE:	DESCRIPTION:
1	AUG.28/03	DWG. REVISED
2	OCT.16/03	TOP RETURN

SUPPLY AIR	
BLOWER ORIENTATION (FACING LEFT HAND SIDE)	CHECK BOX
C.W. 62	<input checked="" type="checkbox"/>
C.C.W. 46	<input type="checkbox"/>
PIPE CONNECTIONS REF.	
1: POOL	3: HOT WATER COIL
2: AIR COOLED A/C	4: DRAIN



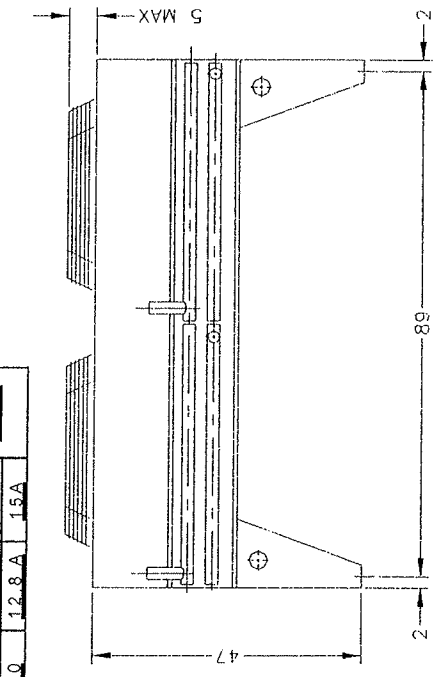
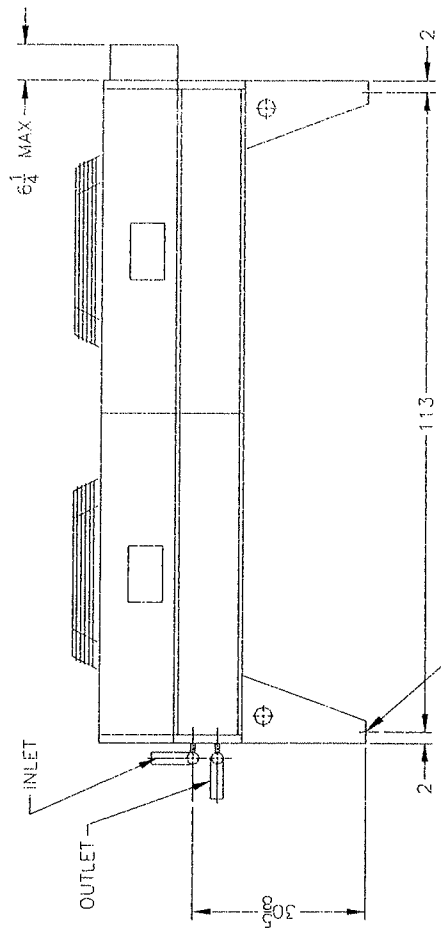
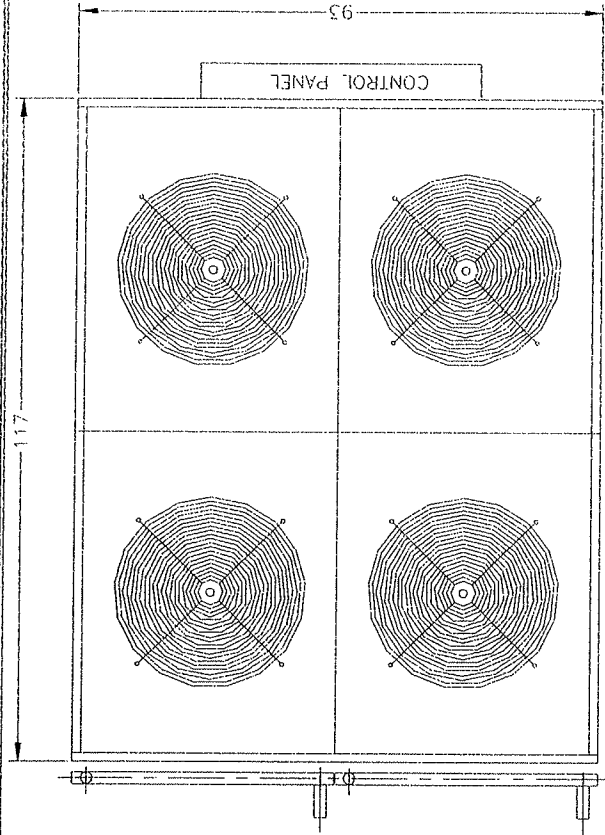
# PAU-1

MODEL	CONNECTION INCHES		REFRIGERANT CHARGE LBS R22		SHIPPING WEIGHT LBS	HP
	INLET	OUTLET	SUMMER	WINTER		
CLD042	(2) 1 3/8	(2) 1 3/8	23	75	1625	1
CLD049	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CLD053	(2) 1 5/8	(2) 1 3/8	35	115	1781	
CLD056	(2) 1 5/8	(2) 1 3/8	47	153	1882	
CLD060	(2) 1 5/8	(2) 1 3/8	47	153	1934	
CL8036	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CL8047	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CL8053	(2) 1 5/8	(2) 1 3/8	47	153	1882	
CID046	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CID054	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CID058	(2) 1 5/8	(2) 1 3/8	35	115	1781	
CID064	(2) 1 5/8	(2) 1 3/8	47	153	1882	
<b>X</b> CID068	(2) 1 5/8	(2) 1 3/8	47	153	1934	
CH8040	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CH8051	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CH8058	(2) 1 5/8	(2) 1 3/8	47	153	1882	

VOLTAGE	AMP	FUSE	HP
2.08-2.40/3/60	18.7 A	20A	1
6.00/3/60	6.8 A	15A	
4.80/3/60	8.5 A	15A	
2.08-2.40/3/60	25.5 A	30A	1 1/2
6.00/3/60	9.8 A	15A	
<b>X</b> 4.80/3/60	12.8 A	15A	

CONTROL:

<input checked="" type="checkbox"/>	24 V
<input type="checkbox"/>	208-240 V
<input type="checkbox"/>	120 V



CONDENSER (2 x 2)  
SEE TABLE

**REFPLUS**  
1.855A Dr. Couderc  
3408 Thibault Ave., P.O.  
Box 1716  
Tulsa, OK 74112  
TEL: (513) 841-2665  
FAX: (513) 841-4554

CL10006

REV	DATE	BY	DESCRIPTION

UNLESS OTHERWISE SPECIFIED:  
DIMENSIONS ARE IN INCHES  
TOLERANCES  
FRACTIONAL: 1/32 DECIMAL: .010 ANGLE: 2°  
DRAWN BY: Y. CLOUTIER DATE: 97-11-15 MATERIAL:  
CHECK BY: DATE:

NOTES:

DESCRIPTION:

# DRY-O-TRON®

## Load Summary and DRY-O-TRON® Selection

3/10/2003

Project: U of MO Aquatic Center Competition Pool  
 Room Temperature: 82 °F DB  
 Relative Humidity Range: Active : 54 % Unoccupied : 50 %  
 Active Hours: 14  
 Outdoor Conditions for: Columbia, MO  
 Summer Design: 95 °F DB 75 °F WB  
 Winter Design: -1 °F DB

Prepared by: Michael Keller B.Sc. E. Eng.

Load Source	Load lb/h		Design Criteria			Primary Water Heater
	Active	Inactive				
Pool #1 (School/University)	340.0	265.0	12950 sq ft	78 °F	0.7	Dry-O-Tron
Pool #2 (AquaFit Programs)	188.8	152.7	4390 sq ft	86 °F	0.65	Dry-O-Tron
Pool #3 (Whirlpool/Spa)	15.4	7.9	97 sq ft	104 °F	1	By Others
Pool #4 ( )	0	0	sq ft	°F		By Others
Pool #5 ( )	0	0	sq ft	°F		By Others
Outdoor Air	159.9	0.0	25,600 CFM			N/A
Spectators	261.0		1,275@.205			N/A
Total Dehumidification load	965.1	425.6				

### DRY-O-TRON® SELECTION

Design Day Run time: 68%

3 x DS-242 Purge & SS c/w 3900 CFM OA Min  
 DS-242 Purge & SS c/w 13900 CFM OA Min

### Swim Meet Verification

Software version: 2.0.1

USA 10935 Crabapple Road Suite202B Roswell, GA 30075 Tel: (770) 649-0102 Fax: (770) 649-0243  
 Canada 4300 Poirier Blvd., Montreal, QC H4R 2C5 Tel: (514) 334-9609 Fax: (514) 334-9184



PROJECT: U of MO AQUATIC CENTER COMP. POOL	
LOCATION: COLUMBIA, MO	
SERIAL NO. : -	BY: A.M. DATE: October/22/03
Tag: PAU-2	Rev: 3

**SUBMITTAL DATA FOR DRY-O-TRC® MODEL: DS 242 - 43** ONE OF FOUR UNITS

**DESIGN PARAMETER:**

Space Temperature: 82.0 °F  
 Relative Humidity Range: 54 % RH  
 Outdoor Design Summer: 95/75 °F DB/WB  
 Winter: -1.0 °F DB  
 Minimum Outdoor Air: 3900 CFM

POOL	Surface Area Sq Ft	Water Temp. °F	Heated by D-O-T Y/N	Aux. Pool Htr Req'd Y/N
1	12950/4	82.0	Y	Y
2	4390/4	85.0	Y	Y
3	97/4	104.0	N	Y
4	-	-	-	-

ELECTRICAL DAT/	Unit	Electric Heater	O/A Cooled Condenser
Voltage/Phase/Hz	460/3/60	-	460/3/60
Minimum Ampacity	143	-	13
Maximum Main Fuse	175.0	-	15.0
Control Voltage	24	-	24
Stages	2	-	2
Total kW	71.7	-	4.5

	HP	FLA	LRA	RPM
Compressor 1	30	52.5	283.0	1750
Compressor 2	22	32.8	187.0	1750
Blower Motor 1	30	35.7	-	1760
EF 1	5	6.6	-	1760
EF 2	25	29.8	-	1760
OAC Cond. 1	1.5 (4)	12.0	-	1140
Glycol Pump	1.5	2.1	-	3500

**PERFORMANCE DAT/**

Moisture Removal at 54% RH: 257.8 lb/h

Total Cooling: 697330 Btu/h  
 DX Coil Sensible Cooling: 392060 Btu/h

**FLUID COOLED CONDENSER or HEATING CC**

	#1	#2	#3	#4
Fluid	water	water	water	-
Application	pool heat	pool heat	space heat	-
Type	vent/coax	vent/coax	HW coil	-
EWT	82.0	85.0	180.0	-
LWT (max)	93.7	96.2	150.0	-
GPM	60.0	20.0	63.0	-
Fluid ΔP PSI	6.0	6.0	1.4	-
Fouling Factor	0.00025	0.00025	-	-
Connections	2-1/8" O.D.	1-1/4" I.D.	see DWG.	-

**AIR HANDLING CHARACTERISTIC**

CFM	O/A	S/A	E/A	R/A
27000/3900/0	27000	27000/4100/0	27000/27200/27000	
ESP " WC	-	1.70	0.50	-1.25
TSP " WC	Blower 1	4.55	EF 1 & EF 2	2.95 / 2.15
Filter #/Size	5/20"x20"x2"		5/20"x20"x2"	
Filter #/Size	15/25"x20"x2"		15/25"x20"x2"	

**COIL PERFORMANCE**

CFM				*Heat Recover	
	Evap.	Reheat	Heating	EA	OA
11000	11000	27000	27000	4100	3900
Cap. (MBH)	697.3	817.1	950.0	189.5	189.5
Ent. DB/WE	82/69.6	68.6/61.3	65.0	82.0	-1.0
Lvg. DB/WE	49.2/48.8	96.6/71.2	97.6	56.6	43.8
Coating	HyPoxy®	HyPoxy®	HyPoxy®	HyPoxy®	HyPoxy®
Rows/FPI	8/10	4/12	1/12	6/10	6/10

**OUTDOOR AIR COOLED CONDENSER / DRY COOL**

Model: CID058

Heat Rejection at 100 °F Air on OACC: 694535 Btu/h

Distance from DRY-O-TRC®: 75 Ft

Same level, Below or Above: Above 30ft

Piping: Hot Gas / Supply: 2 x 1-5/8" O.D.  
 Liquid / Return: 2 x 1-3/8" O.D.

Total Refrigerant Charge: 620.0 lbs R22  
 Min. Factory Refrigerant Charge: 235.0 lbs R22  
 \* Please Refer to Attached SS Performa

**REFERENCE ATTACHMENT**

Dimension Drawing #: DS-NM 242-316 AE REV.1  
 Field Wiring Drawing #: FS-CW 000-024 AE  
 OAC Cond./ Drawing #: CL10006

- Notes:**
- SEMI-HERMETIC COMPRESSORS.
  - TWO SEPARATE EXHAUST DUCTS.
  - NET SENSIBLE COOLING INCLUDING O/A LOAD = 247 MBH.
  - 1-1/2" HW COIL MODULATING VALVE ΔP = 4.8 PSIG.

## PAU-2 Winter SS Performance Oct 21 2003

PAU-2 Winter

OA Winter

PRG:cWATERH \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-21-2003  
- RATING -  
CFM 3900 INSIDE COEFF(Hi) = 477.2  
EDB -1.00 OUTSIDE COEFF(Ho) = 17.8  
LDB 43.80  
- - THERMAL COND(k) = 0.273  
SENS HT 189500 VIS(CENTIPOISE) = 3.61  
EWT/LWT 52.6 / 44.8 SP. HEAT = 0.85  
GPM 54.0 FREEZE POINT = -2.9 DENSITY = 65.50  
WV 4.6 REYNOLDS NUMBER = 5202  
FPD,PSI 4.4 HT.TRANSFER RATE = 11.15  
NO. CIR 19 LOG MEAN TEMP = 22.42  
FV 591.2 FPI = 10  
APD 0.81 ROW = 6  
FH = 23.750 FL = 40.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 6.60 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 19 - 6 - 10 - 40.0 CONN. SIZE = 2.125

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410\*\*\*  
Print this screen? (Y/N) >

EA Winter

PRG:cWATERC \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-21-2003  
- RATING -  
CFM 4100 INSIDE COEFF(Hi) = 451.5  
EDB/EWB 82.0 / 70.0 OUTSIDE COEFF(Ho) = 16.1  
LDB/LWB 56.6 / 56.0 WET OUTSIDE COEFF(Ho) = 16.1  
MBH 188.29 THERMAL COND(k) = 0.273  
MSH 112.99 VIS(CENTIPOISE) = 3.67  
EWT/LWT 44.8 / 52.6 SP. HEAT = 0.85  
GPM 54.0 FREEZE POINT = -2.9 DENSITY = 65.51  
WV 4.6 REYNOLDS NUMBER = 5143  
FPD,PSI 6.4 HT.TRANSFER RATE = 10.30  
NO. CIR 19 LOG MEAN TEMP = 19.29  
FV 497.2 FPI = 10  
APD 0.80 ROW = 6  
FH = 47.500 FL = 25.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 8.25 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 38 - 6 - 10 - 25.0 CONN. SIZE = 2.125

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410 ; APPLIES WHEN EDB >=35 \*\*\*  
Print this screen? (Y/N) >



# PAU-2 Supply Fan

**Data Input:**

Volume	27000 CFM	Elevation	0 ft
Stat. Pressure	4.55 In.W.G.	Temperature	68.0 °F
Ducted outlet		Density	0.075 lb/cu.ft

Selected model: ATZAF 32-32 T2

Moment of inertia lb ft <sup>2</sup>	RPM max 1/min	BHP max BHP	Ø Shaft Inches
232.00	1700	66.50	2-3/16"

**Operating data:**

o.v. ft/min	ptot In.W.G.	pstat In.W.G.	pdyn In.W.G.	tip speed ft/min	RPM 1/min	η stat. %	fan BHP BHP	P min BHP
2474.9	4.93	4.55	0.38	9804.0	1189	73.7	26.30	28.93

**Total Sound Power Level Lw4 inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw4 tot [dB]
Lwoct4 [dB]	97	92	94	90	87	80	75	70	100

**Total Sound Power Level LwA4 (filter A) inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA4 tot [dBA]
LwA4 oct [dBA]	71	76	85	87	87	81	76	69	92

**Total Sound Power Level Lw6d outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw6d tot [dB]
Lwoct6d [dB]	92	90	94	90	87	80	75	70	98

**Total Sound Power Level LwA6d (filter A) outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA6d tot [dBA]
LwA6d oct [dBA]	66	74	85	87	87	81	76	69	92

$LwA4 \text{ tot [dBA]} = LwA6d \text{ tot [dBA]} = LwA7 \text{ tot [dBA]}$

Power rating (BHP) does not include drive losses

Performance ratings do not include the effects of appurtenances in the airstream.



# PAU-2 Min Exhaust Fan

**Data Input:**

Volume	4100 CFM	Elevation	0 ft
Stat. Pressure	2.95 In.W.G.	Temperature	68.0 °F
Ducted outlet		Density	0.075 lb/cu.ft

Selected model: ATZAF 15-15 T2

Moment of inertia lb ft <sup>2</sup>	RPM max 1/min	BHP max BHP	Ø Shaft Inches
10.50	3500	15.00	1-7/16"

**Operating data:**

o.v. ft/min	ptot In.W.G.	pstat In.W.G.	pdyn In.W.G.	tip speed ft/min	RPM 1/min	η stat. %	fan BHP BHP	P min BHP
2002.8	3.20	2.95	0.25	7765.0	1883	63.1	3.02	3.48

**Total Sound Power Level Lw4 inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw4 tot [dB]
Lwoct4 [dB]	98	94	92	80	79	72	69	62	100

**Total Sound Power Level LwA4 (filter A) inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA4 tot[dBA]
LwA4 oct [dBA]	71	78	83	76	79	73	70	61	86

**Total Sound Power Level Lw6d outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw6d tot[dB]
Lwoct6d [dB]	88	88	90	80	79	72	69	62	94

**Total Sound Power Level LwA6d (filter A) outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA6d tot[dBA]
LwA6d oct [dBA]	61	72	81	76	79	73	70	61	86

$LwA4 \text{ tot [dBA]} = LwA6d \text{ tot [dBA]} = LwA7 \text{ tot [dBA]}$

Power rating (BHP) does not include drive losses

Performance ratings do not include the effects of appurtenances in the airstream.



# PAU-2 Purge Fan

**Data Input:**

Volume	22900 CFM	Elevation	0 ft
Stat. Pressure	2.15 In.W.G.	Temperature	68.0 °F
Ducted outlet		Density	0.075 lb/cu.ft

Selected model: **ATZAF 25-25 T2**

Moment of inertia lb ft <sup>2</sup>	RPM max 1/min	BHP max BHP	Ø Shaft Inches
82.80	2200	50.00	2"

**Operating data:**

o.v. ft/min	ptot In.W.G.	pstat In.W.G.	pdyn In.W.G.	tip speed ft/min	RPM 1/min	η stat. %	fan BHP BHP	P min BHP
3317.6	2.83	2.15	0.68	9865.1	1519	42.9	18.12	19.94

**Total Sound Power Level Lw4 inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw4 tot [dB]
Lwoct4 [dB]	101	95	96	92	88	83	79	75	103

**Total Sound Power Level LwA4 (filter A) inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA4 tot[dBA]
LwA4 oct [dBA]	75	79	87	89	88	84	80	74	94

**Total Sound Power Level Lw6d outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw6d tot[dB]
Lwoct6d [dB]	95	92	95	92	88	83	79	75	100

**Total Sound Power Level LwA6d (filter A) outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA6d tot[dBA]
LwA6d oct [dBA]	69	76	86	89	88	84	80	74	94

**LwA4 tot [dBA] = LwA6d tot [dBA] = LwA7 tot [dBA]**

Power rating (BHP) does not include drive losses

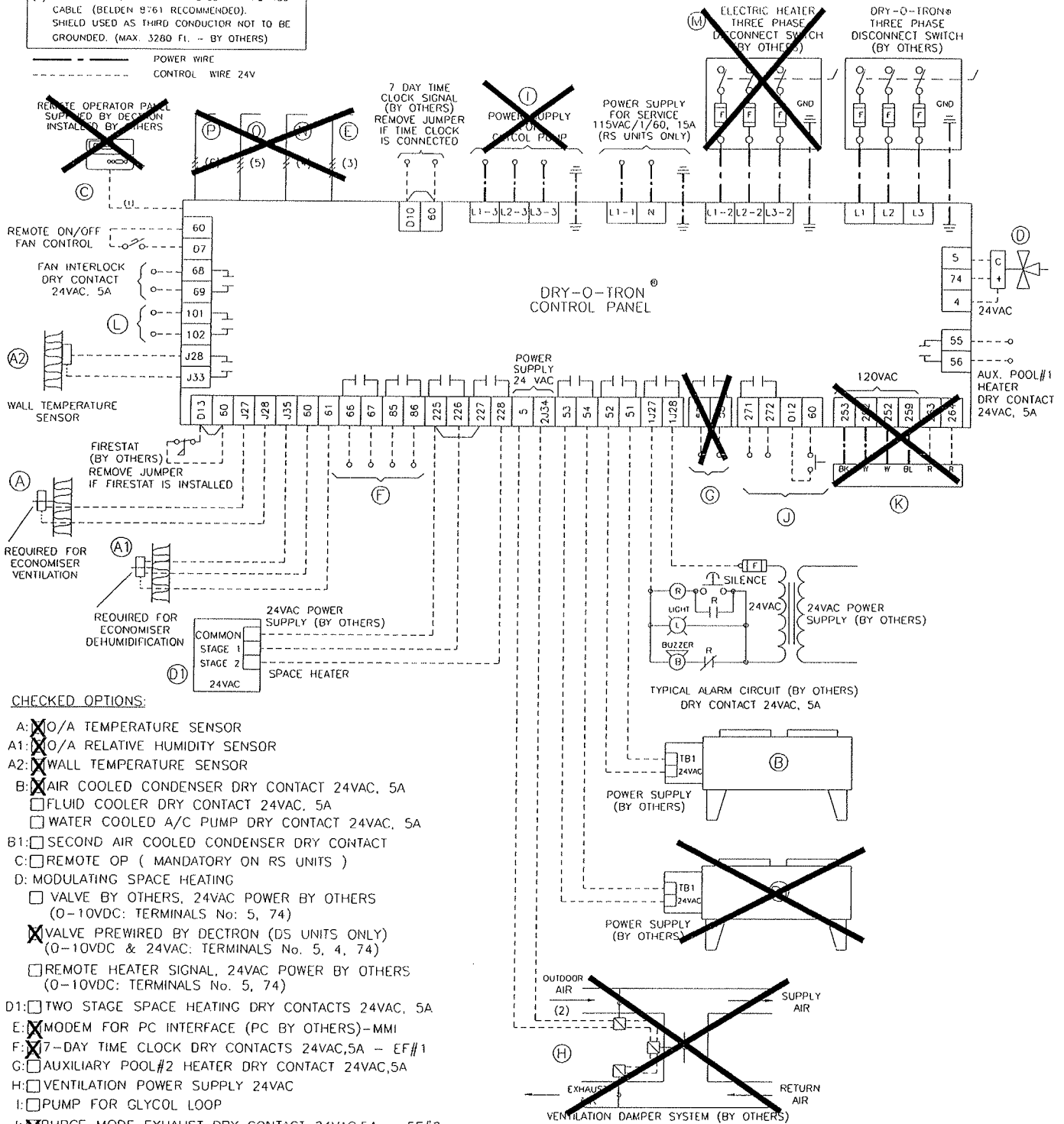
Performance ratings do not include the effects of appurtenances in the airstream.



- CONTROL WIRE SIZE MIN. 20 AWG. EXCEPT:
- 4 WIRE SHIELDED CABLE, MINIMUM 18 GAUGE. (MAX. 3280 FT. - BY OTHERS)
  - WIRE SIZE 16 AWG.
  - 4 WIRE PHONE CABLE.
  - 2 CONDUCTOR TWISTED PAIR RS-485 CABLE, ALPHA CABLE Co. 6222C OR BELDEN 3106A RECOMMENDED. (MAX. 3280 FT. - BY OTHERS) SHIELD TO BE GROUNDED AT ONE END ONLY.
  - WIRING BY BMS CONTRACTOR (SHALL COMPLY WITH ECHELON CORPORATION GUIDELINES)
  - SHIELDED 2 CONDUCTOR TWISTED PAIR RS-485 CABLE (BELDEN 8761 RECOMMENDED). SHIELD USED AS THIRD CONDUCTOR NOT TO BE GROUNDED. (MAX. 3280 FT. - BY OTHERS)

SEE TECHNICAL SPECIFICATIONS FOR MINIMUM AMPACITY AND MAXIMUM MAIN FUSE

# PAU-2



**CHECKED OPTIONS:**

- A:  O/A TEMPERATURE SENSOR
- A1:  O/A RELATIVE HUMIDITY SENSOR
- A2:  WALL TEMPERATURE SENSOR
- B:  AIR COOLED CONDENSER DRY CONTACT 24VAC, 5A
  - FLUID COOLER DRY CONTACT 24VAC, 5A
  - WATER COOLED A/C PUMP DRY CONTACT 24VAC, 5A
- B1:  SECOND AIR COOLED CONDENSER DRY CONTACT
- C:  REMOTE OP ( MANDATORY ON RS UNITS )
- D: MODULATING SPACE HEATING
  - VALVE BY OTHERS, 24VAC POWER BY OTHERS (0-10VDC: TERMINALS No. 5, 74)
  - VALVE PREWIRED BY DECTRON (DS UNITS ONLY) (0-10VDC & 24VAC: TERMINALS No. 5, 4, 74)
  - REMOTE HEATER SIGNAL, 24VAC POWER BY OTHERS (0-10VDC: TERMINALS No. 5, 74)
- D1:  TWO STAGE SPACE HEATING DRY CONTACTS 24VAC, 5A
- E:  MODEM FOR PC INTERFACE (PC BY OTHERS)-MMI
- F:  7-DAY TIME CLOCK DRY CONTACTS 24VAC,5A - EF#1
- G:  AUXILIARY POOL#2 HEATER DRY CONTACT 24VAC,5A
- H:  VENTILATION POWER SUPPLY 24VAC
- I:  PUMP FOR GLYCOL LOOP
- J:  PURGE MODE EXHAUST DRY CONTACT 24VAC,5A - EF#2 AND REMOTE PUSH BUTTON (BY OTHERS)
- K:  REMOTE GAS BOILER
- L:  DIRTY FILTER ALARM DRY CONTACT 24VAC,5A
- M:  UNIT MOUNTED ELECTRIC HEATER WITH SEPARATE POWER CONNECTION
- N:  MODBUS™ INTERFACE
- O:  LONWORKS® INTERFACE
- P:  BACnet™ INTERFACE

# DRY-O-TRON®

## Load Summary and DRY-O-TRON® Selection

8/28/2003

Prepared by: Michael Keller B.Sc. E. Eng.

Project: U of MO Aquatic Center Competition Pool  
 Room Temperature: 82 °F DB  
 Relative Humidity Range: Active : 54 % Unoccupied : 50 %  
 Active Hours: 14  
 Outdoor Conditions for: Columbia, MO  
 Summer Design: 95 °F DB 75 °F WB  
 Winter Design: -1 °F DB

Load Source	Load lb/h		Design Criteria			Primary Water Heater
	Active	Inactive				
Pool #1 (School/University)	672.6	352.5	12950 sq ft	82 °F	1	Dry-O-Tron
Pool #2 (Diving Well)	177.8	144.1	4390 sq ft	85 °F	0.65	Dry-O-Tron
Pool #3 (Whirlpool/Spa)	15.50	7.90	97 sq ft	104 °F	1	By Others
Pool #4						
Pool #5						
Outdoor Air	97.4		15600 CFM			N/A
Spectators	15.4		75@.205			N/A
Total Dehumidification load	244.7	126.1				

DRY-O-TRON® SELECTION Special Unit PAU-3 DS-242-SS & Purge Design Day Run time: 73%  
 3 x DS 242 SS & Purge

### Air Cooled Condenser Auxiliary Heat Rejection & System Charge

Air on condenser: 100

Total heat rejection required: 817100 btu/h

Condenser Model	Voltage	MCA	Fuse/MOP	Qty of Fans	HP/Fan	Weight (lbs)	RPM
CID058	460/3/60	12.8	15	4	1.50	1781	1140

Total line length between outdoor air cooled condenser and the DRY-O-TRON (ft): 75

The condenser is: 30 ft Above the DRY-O-TRON  
 Line sizes to the condenser:  
 Standard Unit 1 5/8 Hot gas 1 3/8 Liquid  
 1 5/8 Hot gas 1 3/8 Liquid

Refrigerant type: R-22 Standard Unit  
 Factory Charge (lbs): 150  
 System Charge (lbs): 535

Field Charge by installing contractor (lbs): 385

### Notes:

- 1) Ensure there is clearance around the perimeter of the condenser equal to its width
- 2) Do not deviate from the recommended line sizes to the outdoor condenser.
- 3) Multiple fan units have ambient thermostat (factory supplied) controlled fan cycling kits.
- 4) Contactor and 24 volt transformer included.
- 5) Ensure traps are installed at all elevation changes and every 20' of riser.
- 6) A separate power supply is required to the outdoor air cooled condenser.
- 7) Disconnect by others

Software version: 2.0.1

USA 10935 Crabapple Road Suite202B Roswell, GA 30075 Tel: (770) 649-0102 Fax: (770) 649-0243  
 Canada 4300 Poirier Blvd., Montreal, QC H4R 2C5 Tel: (514) 334-9609 Fax: (514) 334-9184

## PAU-3 Winter SS Performance Oct 21 2003

PAU-3 Min Winter

OA Winter

PRG:cWATERH \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-21-2003  
- RATING -  
CFM 3900 INSIDE COEFF(Hi) = 500.8  
EDB -1.00 OUTSIDE COEFF(Ho) = 17.7  
LDB 43.84  
- - THERMAL COND(k) = 0.273  
SENS HT 189652 VIS(CENTIPOISE) = 3.64  
EWT/LWT 52.2 / 44.4 SP. HEAT = 0.85  
GPM 54.0 FREEZE POINT = -2.9 DENSITY = 65.51  
WV 4.9 REYNOLDS NUMBER = 5451  
FPD,PSI 4.7 HT.TRANSFER RATE = 11.32  
NO. CIR 18 LOG MEAN TEMP = 21.88  
FV 585.0 FPI = 10  
APD 0.79 ROW = 6  
FH = 15.000 FL = 64.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 6.67 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 12 - 6 - 10 - 64.0 CONN. SIZE = 2.125

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410\*\*\*  
Print this screen? (Y/N) >

EA Winter

PRG:cWATERC \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-21-2003  
- RATING -  
CFM 4100 INSIDE COEFF(Hi) = 449.4  
EDB/EWB 82.0 / 70.0 OUTSIDE COEFF(Ho) = 16.1  
LDB/LWB 56.4 / 55.8 WET OUTSIDE COEFF(Ho) = 16.1  
MBH 190.73 THERMAL COND(k) = 0.273  
MSH 113.94 VIS(CENTIPOISE) = 3.70  
EWT/LWT 44.4 / 52.3 SP. HEAT = 0.85  
GPM 54.0 FREEZE POINT = -2.9 DENSITY = 65.52  
WV 4.6 REYNOLDS NUMBER = 5106  
FPD,PSI 6.4 HT.TRANSFER RATE = 10.31  
NO. CIR 19 LOG MEAN TEMP = 19.53  
FV 497.2 FPI = 10  
APD 0.80 ROW = 6  
FH = 47.500 FL = 25.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 8.25 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 38 - 6 - 10 - 25.0 CONN. SIZE = 2.125

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410 ; APPLIES WHEN EDB >=35 \*\*\*  
Print this screen? (Y/N) >

PAU-3 Summer SS Performance Oct 21 2003

PAU-3 Min Summer

OA Summer

PRG:cWATERC \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-21-2003  
- RATING -  
CFM 3900 INSIDE COEFF(Hi) = 579.7  
EDB/EWB 95.0 / 75.0 OUTSIDE COEFF(Ho) = 17.7  
LDB/LWB 88.9 / -  
MBH - THERMAL COND(k) = 0.274  
MSH 25.77 VIS(CENTIPOISE) = 2.08  
EWT/LWT 87.6 / 88.7 SP. HEAT = 0.87  
GPM 54.0 FREEZE POINT = -2.9 DENSITY = 65.05  
WV 4.9 REYNOLDS NUMBER = 9519  
FPD,PSI 4.8 HT.TRANSFER RATE = 10.55  
NO. CIR 18 LOG MEAN TEMP = 3.19  
FV 585.0 FPI = 10  
APD 0.79 ROW = 6  
FH = 15.000 FL = 64.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 6.67 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 12 - 6 - 10 - 64.0 CONN. SIZE = 2.125

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410 ; APPLIES WHEN EDB >=35  
\*\*\*

Print this screen? (Y/N) >

EA Summer

PRG:cWATERH \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-21-2003  
- RATING -  
CFM 4100 INSIDE COEFF(Hi) = 710.5  
EDB 82.00 OUTSIDE COEFF(Ho) = 16.1  
LDB 88.03  
- - THERMAL COND(k) = 0.274  
SENS HT 26808 VIS(CENTIPOISE) = 1.87  
EWT/LWT 88.7 / 87.6 SP. HEAT = 0.87  
GPM 54.0 FREEZE POINT = -2.9 DENSITY = 64.94  
WV 4.6 REYNOLDS NUMBER = 9978  
FPD,PSI 5.2 HT.TRANSFER RATE = 12.17  
NO. CIR 19 LOG MEAN TEMP = 2.33  
FV 497.2 FPI = 10  
APD 0.61 ROW = 6  
FH = 47.500 FL = 25.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 8.25 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 38 - 6 - 10 - 25.0 CONN. SIZE = 2.125

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410\*\*\*

Print this screen? (Y/N) >

# PAU-3



## Supply Fan @ 3.25" ESP (40 HP)

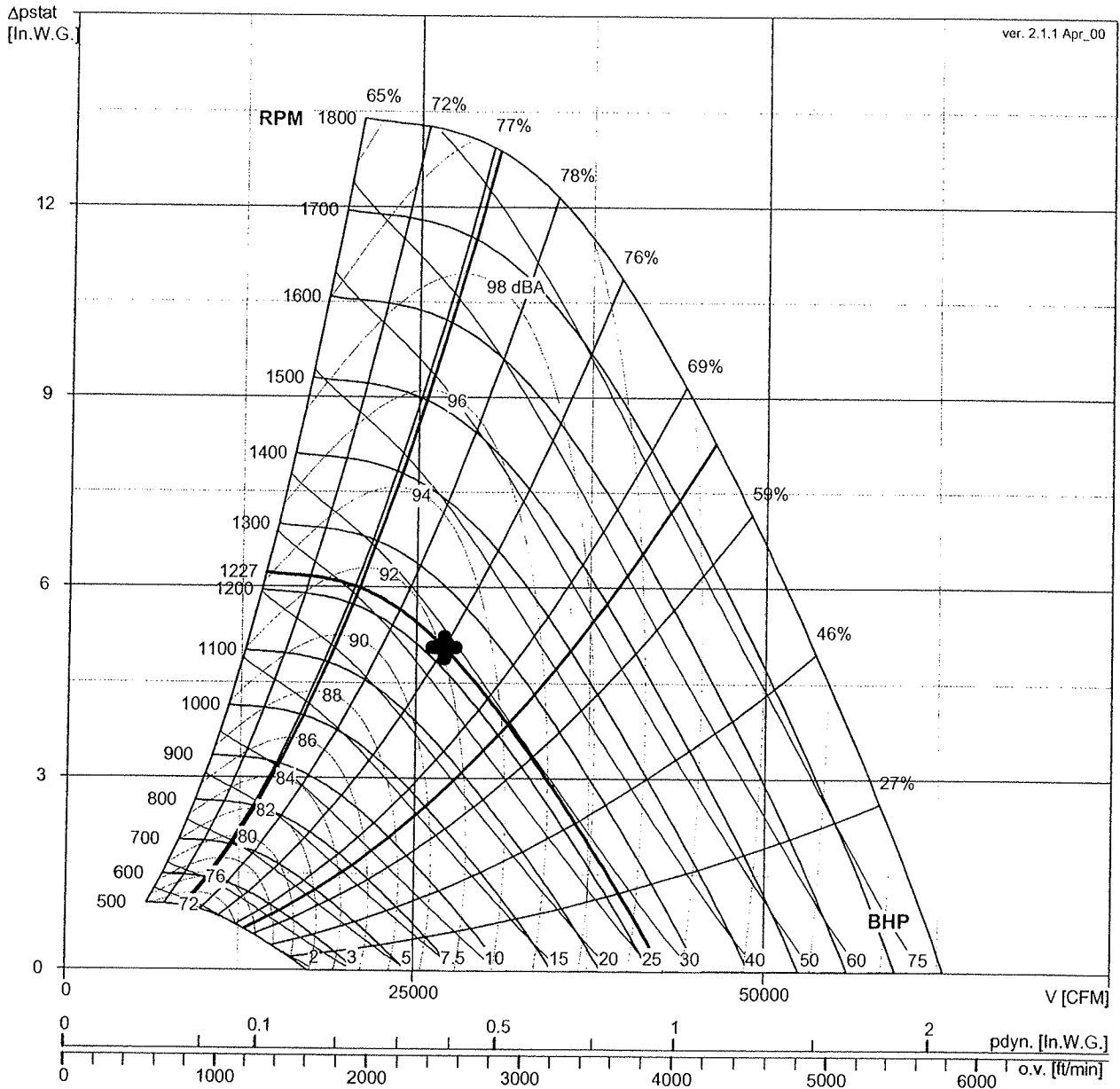
Model/size: ATZAF 32-32  
 Max fan rev.: 1700 RPM  
 Max. fan abs. BHP: 66.5 BHP  
 Moment of inertia: 232.00 lb ft<sup>2</sup>

Fan working condition: Free inlet- Ducted outlet  
 Volume: 27000 CFM  
 Stat. pressure: 5.05 In.W.G.  
 Abs. shaft fan BHP: 28.64 BHP  
 Stat. Efficiency: 75.1 %  
 Temperature: 68.0 °F  
 Elevation: 0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft

Fan plot condition: ATZAF 32-32 T2 Free inlet- Ducted outlet

LwA4;7: A-weighted Sound Power Level inside the fan outlet duct and at fan inlet.



Power rating (BHP) does not include drive losses  
 Performance ratings do not include the effects of appurtenances in the airstream.

# PAU-3

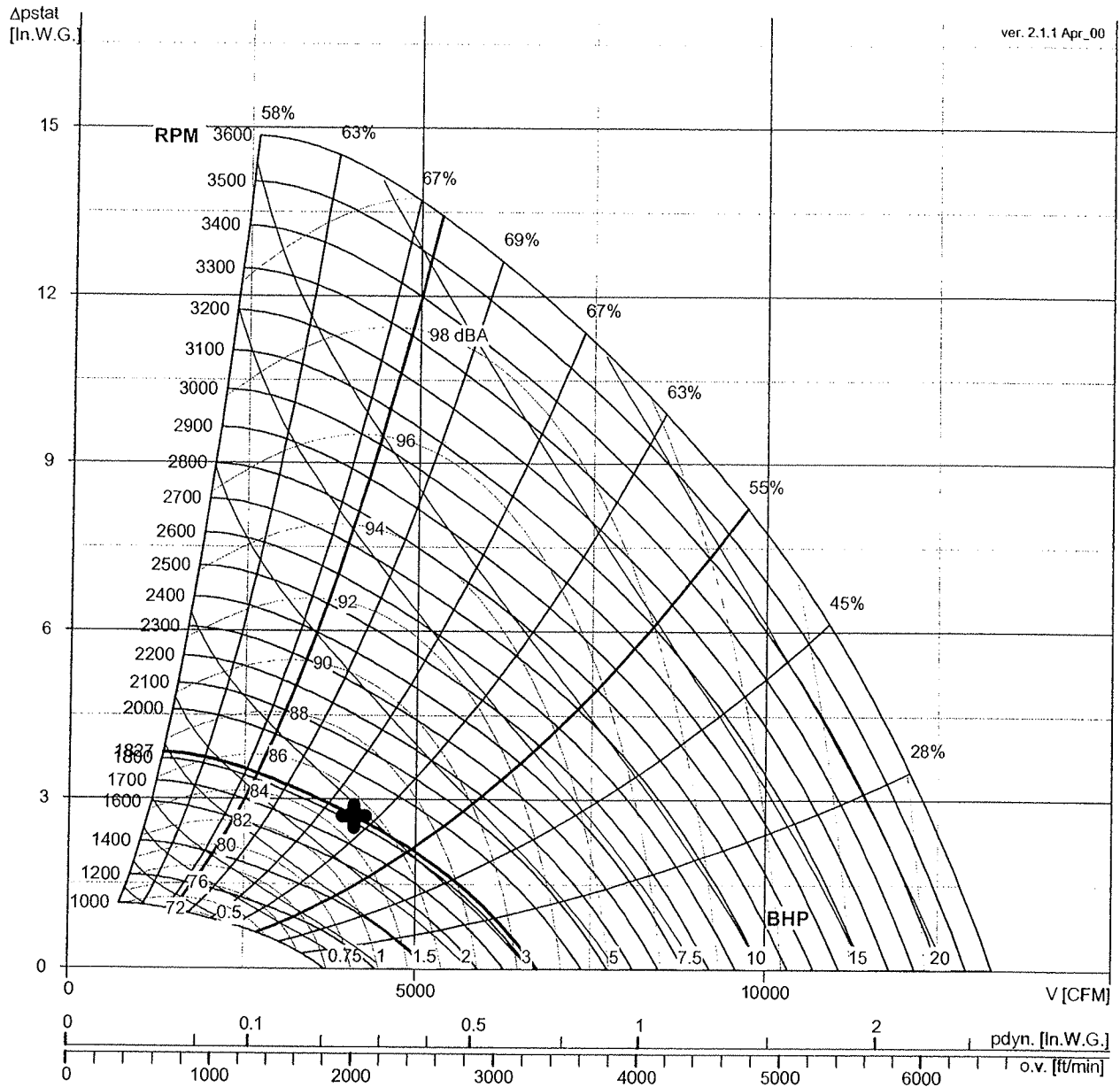


## ExFan1 Min Exhaust @ 1.5" ESP (5 HP)

Model/size: ATZAF 15-15  
 Max fan rev.: 3500 RPM  
 Max. fan abs. BHP: 15.0 BHP  
 Moment of inertia: 10.50 lb ft<sup>2</sup>

Fan working condition: Free inlet- Ducted outlet  
 Volume: 4100 CFM  
 Stat. pressure: 2.70 In.W.G.  
 Abs. shaft fan BHP: 2.81 BHP  
 Stat. Efficiency: 62.2 %  
 Temperature: 68.0 °F  
 Elevation: 0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft  
 Fan plot condition: ATZAF 15-15 T2 Free inlet- Ducted outlet  
 LwA4;7: A-weighted Sound Power Level inside the fan outlet duct and at fan inlet.



Power rating (BHP) does not include drive losses  
 Performance ratings do not include the effects of appurtenances in the airstream.

# PAU-3



## ExFan2 Purge @ 1.5" ESP (10 HP)

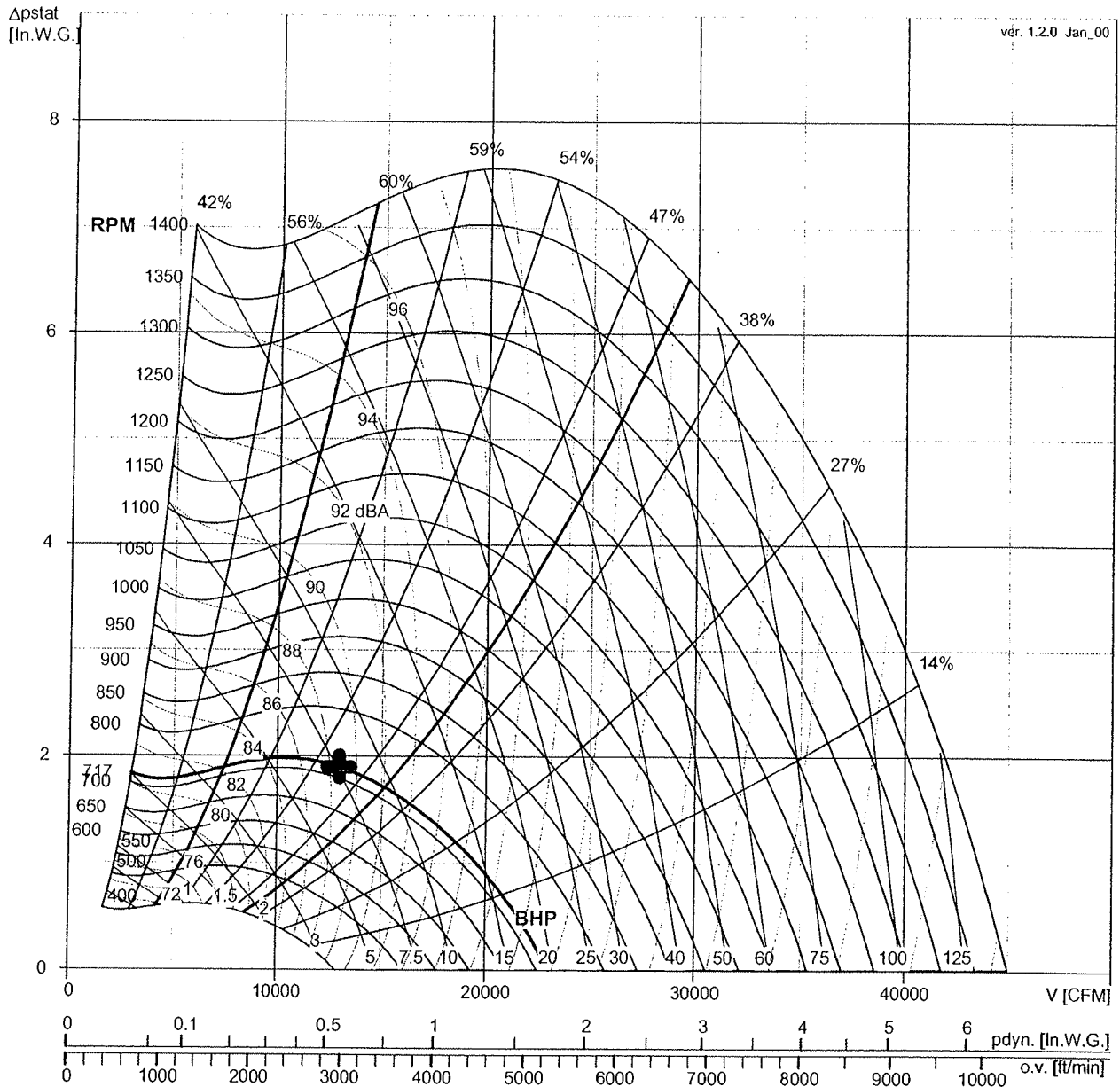
Model/size: ATLI 20 - 20  
 Max fan rev.: 1330 RPM  
 Max. fan abs. BHP: 30.2 BHP  
 Moment of inertia: 21.36 lb ft<sup>2</sup>

Fan working condition: Free inlet- Ducted outlet  
 Volume: 13000 CFM  
 Stat. pressure: 1.90 In.W.G.  
 Abs. shaft fan BHP: 7.67 BHP  
 Stat. Efficiency: 50.8 %  
 Temperature: 68.0 °F  
 Elevation: 0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft

Fan plot condition: ATLI 20 - 20 T2 Free inlet- Ducted outlet

LwA4;7: A-weighted Sound Power Level inside the fan outlet duct and at fan inlet.



Power rating (BHP) does not include drive losses

Performance ratings do not include the effects of appurtenances in the airstream.



comefri

PAU-3

ExFan3 Max Exhaust @ 1.5" ESP (15 HP)

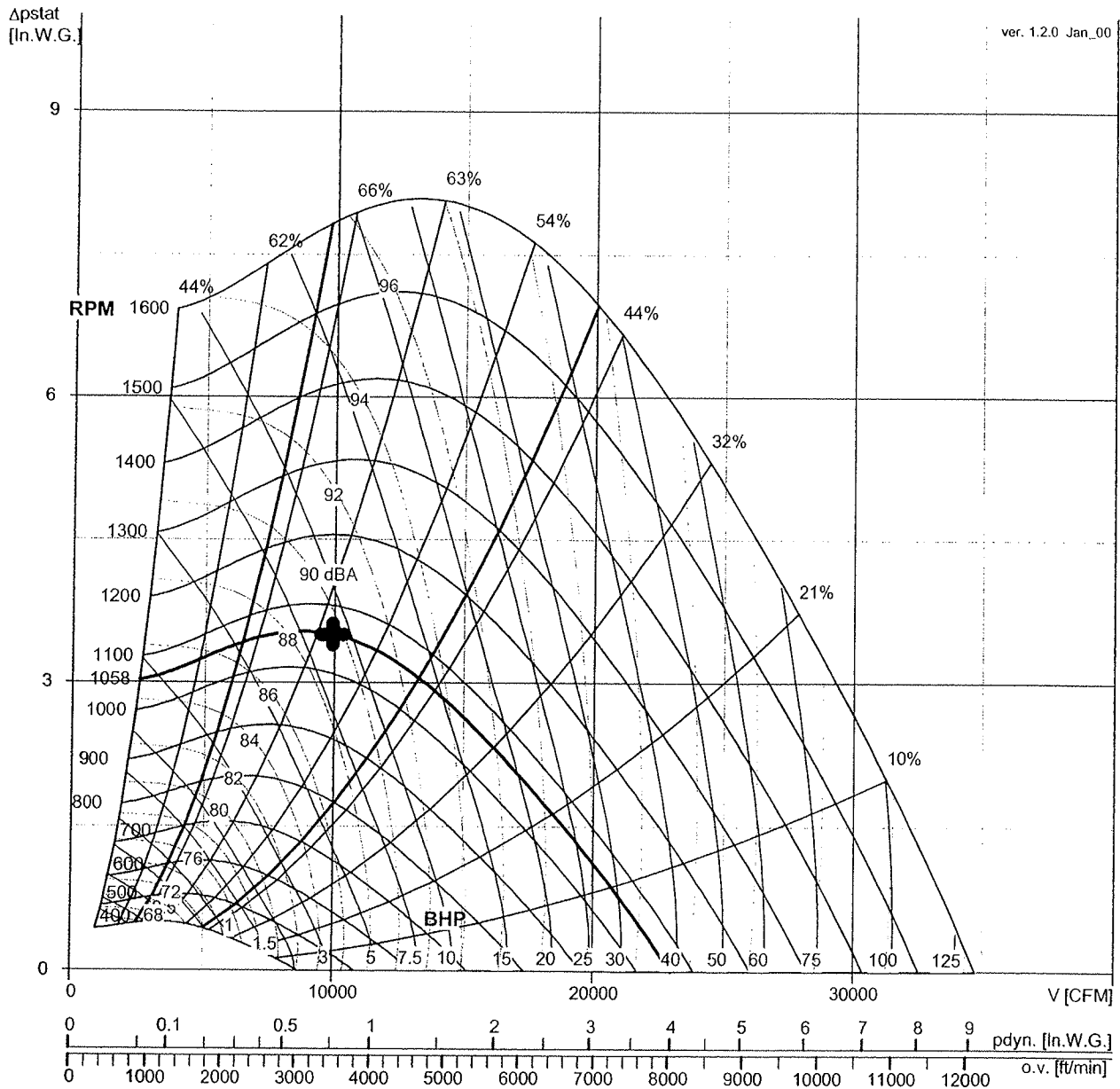
Model/size: ATLI 18 - 18  
 Max fan rev.: 1500 RPM  
 Max. fan abs. BHP: 18.2 BHP  
 Moment of inertia: 10.99 lb ft<sup>2</sup>

Fan working condition: Free inlet- Ducted outlet  
 Volume: 9900 CFM  
 Stat. pressure: 3.50 In.W.G.  
 Abs. shaft fan BHP: 8.99 BHP  
 Stat. Efficiency: 60.8 %  
 Temperature: 68.0 °F  
 Elevation: 0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft

Fan plot condition: ATLI 18 - 18 T2 Free inlet- Ducted outlet

LwA4;7: A-weighted Sound Power Level inside the fan outlet duct and at fan inlet.



Power rating (BHP) does not include drive losses  
 Performance ratings do not include the effects of appurtenances in the airstream.

3.04.01



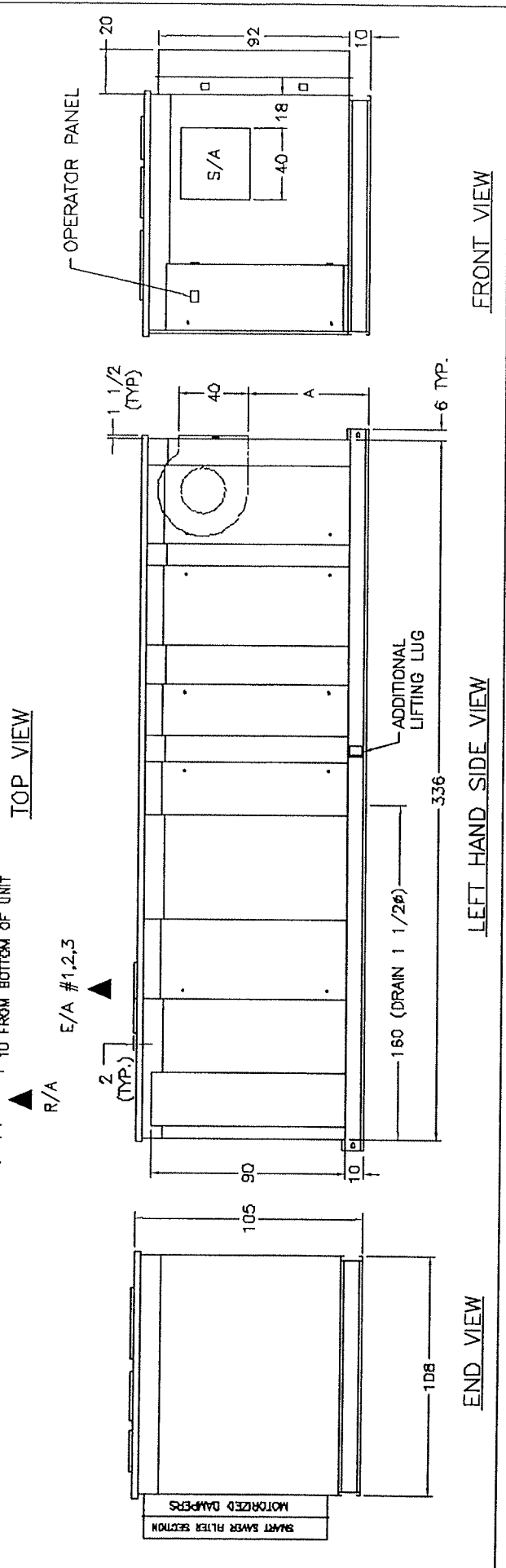
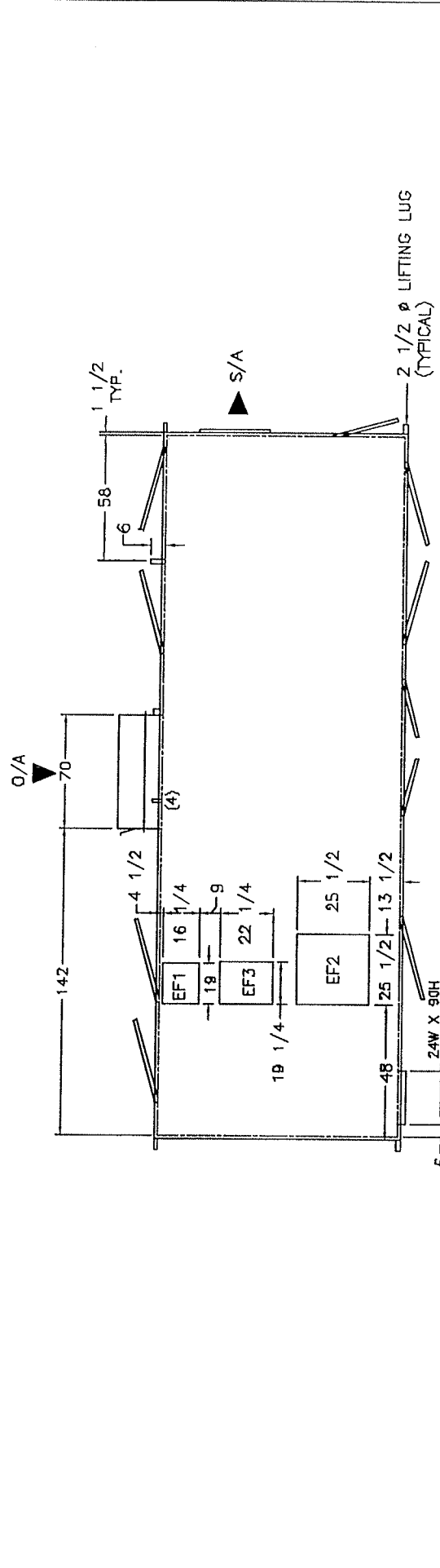
# Dectron

RT-O-TURN

NO. DESSN: DS-NM-242-317 AE REV: 3  
 DWG. NO.: MODEL DS-242  
 TITLE: H.A.D.(CCW), L.S.A.R., R.S.O.A., T.E.A.  
 SMART SAVER, PURGE, SPRING ISOLATED  
 SUPPLY FAN IN DS-282 ENCLOSURE

NOTES: ALL DIMENSIONS ARE IN INCHES.

SUPPLY AIR		REVISION DETAIL		DRAWING DETAIL	
BLOWER ORIENTATION (FACING LEFT HAND SIDE)	ROTATION	NO.	DATE:	DESIGN PAR. DRAWN BY:	R.T.
C.W.	62	1	AUG.29/03	DWG REVISED	22. APR/03
C.C.W.	46	2	SEP.02/03	UNIT-12" L	
PIPE CONNECTIONS REF.		3	OCT.15/03	OPPOSITE SIDE CONNECTIONS	N.T.S.
1: POOL	3: HOT WATER COIL				PAU-3
2: AIR COOLED A/D	4: DRAIN				APPROXIMATE WEIGHT: 19600 lbs. ±10%
					PODS APPROXIMATE:

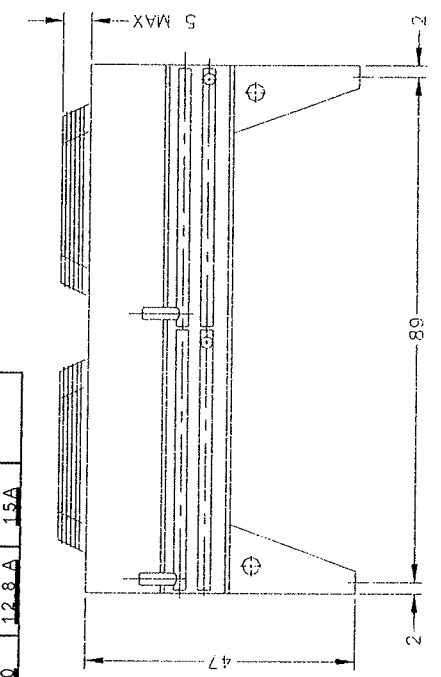
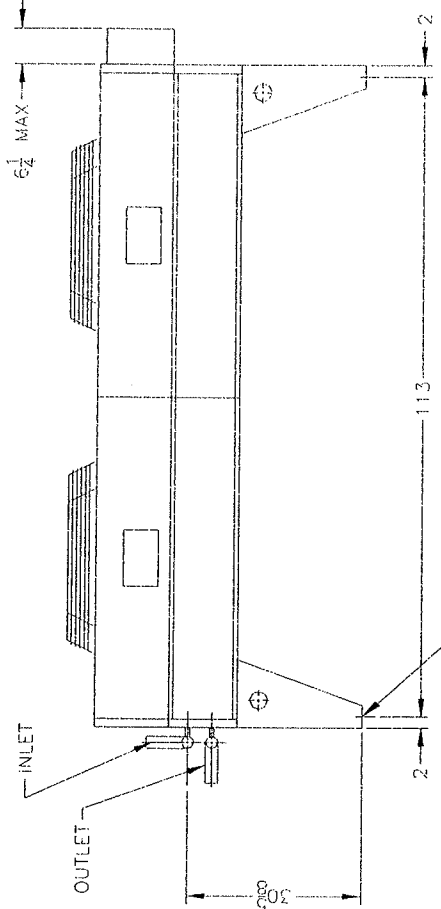
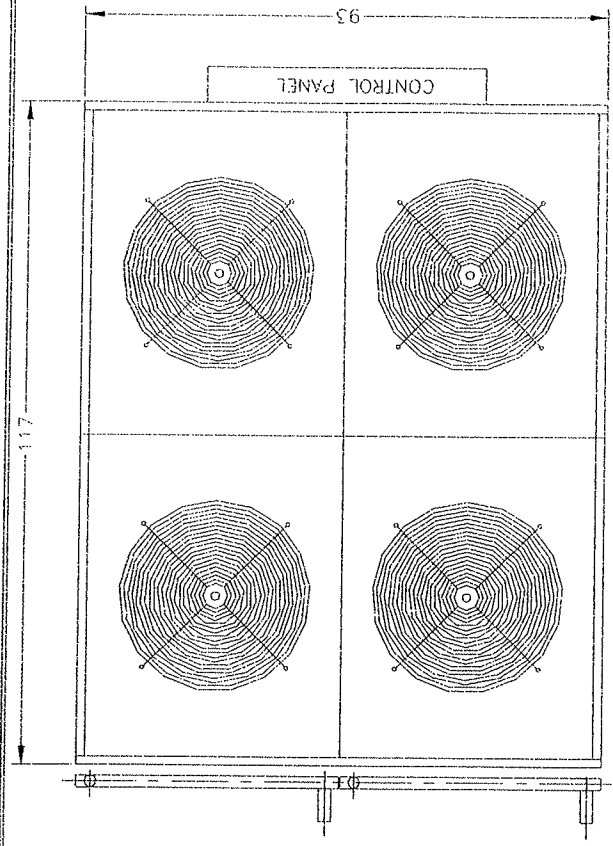


MODEL	CONNECTION INCHES		REFRIGERANT CHARGE LBS R22		SHIPPING WEIGHT LBS	HP
	INLET	OUTLET	SUMMER	WINTER		
CLD042	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CLD049	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CLD053	(2) 1 5/8	(2) 1 3/8	35	115	1781	
CLD056	(2) 1 5/8	(2) 1 3/8	47	153	1882	1
CLD060	(2) 1 5/8	(2) 1 3/8	47	153	1934	
CL8036	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CL8047	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CL8053	(2) 1 5/8	(2) 1 3/8	47	153	1882	
CL8054	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CL8054	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CLD058	(2) 1 5/8	(2) 1 3/8	35	115	1781	
CLD064	(2) 1 5/8	(2) 1 3/8	47	153	1882	
CLD068	(2) 1 5/8	(2) 1 3/8	47	153	1934	
CH8040	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CH8051	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CH8058	(2) 1 5/8	(2) 1 3/8	47	153	1882	

VOLTAGE	AMP	FUSE	HP
208-240/3/60	18.7 A	20A	1
600/3/60	6.8 A	15A	
480/3/60	8.5 A	15A	
208-240/3/60	25.5 A	30A	
600/3/60	9.8 A	15A	1 1/2
480/3/60	12.8 A	15A	

CONTROL:

<input checked="" type="checkbox"/>	24 V
<input type="checkbox"/>	208-240 V
<input type="checkbox"/>	120 V



REFPLUS  
 1385A De Coulemb  
 Bochenville, P.O.  
 J4B 7LB  
 TEL: (514) 841-2662  
 FAX: (514) 841-4554

CONDENSER (2 x 2 )  
 SEE TABLE

UNLESS OTHERWISE SPECIFIED:  
 DIMENSIONS ARE IN INCHES  
 TOLERANCES  
 FRACTION: 1/32 DEC: .010 ANG: 2°

DRAW BY: Y. CLOUTIER DATE: 97-11-18  
 CHECK BY: DATE:

REV.	DATE	BY	DESCRIPTION

ONE NO. CL10006



PROJECT: U of MO AQUATIC CENTER COMP. POOL  
 LOCATION: COLUMBIA, MO  
 SERIAL NO.: - BY: A.M. DATE: October/24/03  
 Tag: PAU-4 Rev: 3

**SUBMITTAL DATA FOR DRY-O-TRON® MODEL: DS 242 - 4; ONE OF FOUR UNITS**

DESIGN PARAMETER:				POOL	Surface Area Sq Ft	Water Temp. °F	Heated by D-O-T Y/N	Aux. Pool Htr Req'd Y/N		
Space Temperature:	82.0	°F		1	12950/4	82.0	Y	Y		
Relative Humidity Range:	54	% RH		2	4390/4	85.0	Y	Y		
Outdoor Design Summer:	95/75	°F DB/WB		3	97/4	104.0	N	Y		
Winter:	-1.0	°F DB		4	-	-	-	-		
Minimum Outdoor Air:	3900	CFM								
ELECTRICAL DATA/	Unit	Electric Heater	O/A Cooled Condenser	Compressor	HP	FLA	LRA	RPM		
				1	30	52.5	283.0	1750		
				2	22	32.8	187.0	1750		
				Blower Motor						
				1	30	35.7	-	1760		
				EF 1	5	6.6	-	1760		
				EF 2	20	24.0	-	1760		
Voltage/Phase/Hz	460/3/60	-	460/3/60	OAC Cond.	1	1.5 (4)	12.0	1140		
Minimum Ampacity	143	-	13	Glycol Pump		1.5	2.1	3500		
Maximum Main Fuse	175.0	-	15.0	<b>FLUID COOLED CONDENSER or HEATING COIL</b>						
Control Voltage	24	-	24		#1	#2	#3	#4		
Stages	2	-	2	Fluid	water	water	water	-		
Total kW	71.7	-	4.5	Application	pool heat	pool heat	space heat	-		
<b>PERFORMANCE DATA</b>				Type	vent/coax	vent/coax	HW coil	-		
Moisture Removal at 54% RH:	257.8	lb/h		EWT	82.0	85.0	180.0	-		
Total Cooling:	697330	Btu/h		LWT (max)	93.7	96.2	150.0	-		
DX Coil Sensible Cooling:	392060	Btu/h		GPM	60.0	20.0	63.0	-		
<b>AIR HANDLING CHARACTERISTIC</b>				Fluid ΔP PSI	6.0	6.0	1.4	-		
	O/A	S/A	E/A	R/A	Fouling Factor	0.00025	0.00025	-		
CFM	27000/3900/0	27000	2700/4100/0	27000/27200/27000	Connections	2-1/8" O.D.	1-1/4" I.D.	see DWG.		
ESP " WC	-	1.70	0.50	-1	<b>COIL PERFORMANCE</b>					
	Blower 1		EF 1 & EF 2					<b>*Heat Recover</b>		
TSP " WC	4.25		2.70 / 1.90		Evap.	Reheat	Heating	EA	OA	
Filter #/Size	5/20"x20"x2"		5/20"x20"x2"		CFM	11000	27000	27000	4100	3900
Filter #/Size	15/25"x20"x2"		15/25"x20"x2"		Cap. (MBH)	697.3	817.1	950.0	189.5	189.5
<b>OUTDOOR AIR COOLED CONDENSER / DRY COOL</b>				Ent. DB/WE	82/69.6	68.6/61.3	65.0	82.0	-1.0	
Model:	CID058			Lvg. DB/WE	49.2/48.8	96.6/71.2	97.6	56.6	43.8	
Heat Rejection at 100 °F Air on OACC	694535 Btu/h			Coating	HyPoxy®	HyPoxy®	HyPoxy®	HyPoxy®	HyPoxy®	
Distance from DRY-O-TRON®	75 Ft			Rows/FPI	8/10	4/12	1/12	6/10	6/10	
Same level, Below or Above	Above 30ft			<b>Total Refrigerant Charge</b> 620.0 lbs R22						
Piping: Hot Gas / Supply	2 x 1-5/8" O.D.			<b>Min. Factory Refrigerant Charge</b> 235.0 lbs R22						
Liquid / Return	2 x 1-3/8" O.D.			<b>* Please Refer to Attached SS Performa</b>						
<b>REFERENCE ATTACHMENT</b>				<b>Notes:</b>						
Dimension Drawing #:	DS-NM 242-318 AE REV.1			• SEMI-HERMETIC COMPRESSORS.						
Field Wiring Drawing #:	FS-CW 000-024 AE			• TWO SEPARATE EXHAUST DUCTS.						
OAC Cond./ Drawing #:	CL10006			• NET SENSIBLE COOLING INCLUDING O/A LOAD = 250 MBH .						
				• 1-1/2" HW COIL MODULATING VALVE ΔP = 4.8 PSIG.						
								FORM # SD REV 1		

PAU-4 Summer SS Performance Oct 21 2003

PAU-4 Summer

OA Summer

PRG:cWATERC \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-21-2003  
- RATING -  
CFM 3900 INSIDE COEFF(Hi) = 554.8  
EDB/EWB 95.0 / 75.0 OUTSIDE COEFF(Ho) = 17.8  
LDB/LWB 88.8 / -  
MBH - THERMAL COND(k) = 0.274  
MSH 26.28 VIS(CENTIPOISE) = 2.08  
EWT/LWT 87.4 / 88.5 SP. HEAT = 0.87  
GPM 54.0 FREEZE POINT = -2.9 DENSITY = 65.06  
WV 4.6 REYNOLDS NUMBER = 9004  
FPD,PSI 4.4 HT.TRANSFER RATE = 10.45  
NO. CIR 19 LOG MEAN TEMP = 3.32  
FV 591.2 FPI = 10  
APD 0.81 ROW = 6  
FH = 23.750 FL = 40.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 6.60 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 19 - 6 -10 - 40.0 CONN. SIZE = 2.125

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410 ; APPLIES WHEN EDB >=35  
\*\*\*

Print this screen? (Y/N) >

EA Summer

PRG:cWATERH \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-21-2003  
- RATING -  
CFM 4100 INSIDE COEFF(Hi) = 709.9  
EDB 82.00 OUTSIDE COEFF(Ho) = 16.1  
LDB 87.85  
- - THERMAL COND(k) = 0.274  
SENS HT 26006 VIS(CENTIPOISE) = 1.87  
EWT/LWT 88.5 / 87.4 SP. HEAT = 0.87  
GPM 54.0 FREEZE POINT = -2.9 DENSITY = 64.94  
WV 4.6 REYNOLDS NUMBER = 9951  
FPD,PSI 5.2 HT.TRANSFER RATE = 12.17  
NO. CIR 19 LOG MEAN TEMP = 2.26  
FV 497.2 FPI = 10  
APD 0.61 ROW = 6  
FH = 47.500 FL = 25.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 8.25 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 38 - 6 -10 - 25.0 CONN. SIZE = 2.125

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410\*\*\*  
Print this screen? (Y/N) >



# PAU-4 Supply Fan

**Data Input:**

<b>Volume</b>	27000 CFM	<b>Elevation</b>	0 ft
<b>Stat. Pressure</b>	4.25 In.W.G.	<b>Temperature</b>	68.0 °F
<b>Ducted outlet</b>		<b>Density</b>	0.075 lb/cu.ft

Selected model: ATZAF 32-32 T2

Moment of inertia lb ft <sup>2</sup>	RPM max 1/min	BHP max BHP	Ø Shaft Inches
232.00	1700	66.50	2-3/16"

**Operating data:**

o.v. ft/min	ptot In.W.G.	pstat In.W.G.	pdyn In.W.G.	tip speed ft/min	RPM 1/min	η stat. %	fan BHP BHP	P min BHP
2474.9	4.63	4.25	0.38	9610.7	1166	72.7	24.92	27.41

**Total Sound Power Level Lw4 inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw4 tot [db]
Lwoct4 [dB]	97	92	94	90	87	80	75	70	100

**Total Sound Power Level LwA4 (filter A) inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA4 tot[dBA]
LwA4 oct [dBA]	70	75	85	86	87	81	76	68	92

**Total Sound Power Level Lw6d outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw6d tot[dB]
Lwoct6d [dB]	92	90	94	90	87	80	75	70	98

**Total Sound Power Level LwA6d (filter A) outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA6d tot[dBA]
LwA6d oct [dBA]	65	73	85	86	87	81	76	68	92

**LwA4 tot [dBA] = LwA6d tot [dBA] = LwA7 tot [dBA]**

Power rating (BHP) does not include drive losses

Performance ratings do not include the effects of appurtenances in the airstream.



# PAU-4 Min Exhaust Fan

**Data Input:**

Volume	4100 CFM	Elevation	0 ft
Stat. Pressure	2.70 In.W.G.	Temperature	68.0 °F
Ducted outlet		Density	0.075 lb/cu.ft

Selected model: **ATZAF 15-15 T2**

Moment of inertia lb ft <sup>2</sup>	RPM max 1/min	BHP max BHP	Ø Shaft Inches
10.50	3500	15.00	1-7/16"

**Operating data:**

o.v. ft/min	ptot In.W.G.	pstat In.W.G.	pdyn In.W.G.	tip speed ft/min	RPM 1/min	η stat. %	fan BHP BHP	P min BHP
2002.8	2.95	2.70	0.25	7532.8	1827	62.2	2.81	3.37

**Total Sound Power Level Lw4 inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw4 tot [dB]
Lwoct4 [dB]	97	93	91	79	78	71	68	61	99

**Total Sound Power Level LwA4 (filter A) inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA4 tot[dBA]
LwA4 oct [dBA]	71	77	83	76	78	72	69	60	85

**Total Sound Power Level Lw6d outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw6d tot[dB]
Lwoct6d [dB]	87	87	89	79	78	71	68	61	93

**Total Sound Power Level LwA6d (filter A) outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA6d tot[dBA]
LwA6d oct [dBA]	61	71	81	76	78	72	69	60	85

**LwA4 tot [dBA] = LwA6d tot [dBA] = LwA7 tot [dBA]**

Power rating (BHP) does not include drive losses

Performance ratings do not include the effects of appurtenances in the airstream.



# PAU-4 Purge Fan

**Data Input:**

<b>Volume</b>	22900 CFM	<b>Elevation</b>	0 ft
<b>Stat. Pressure</b>	1.93 In.W.G.	<b>Temperature</b>	68.0 °F
<b>Ducted outlet</b>		<b>Density</b>	0.075 lb/cu.ft

Selected model: ATLI 25 - 25 T2

Moment of inertia lb ft <sup>2</sup>	RPM max 1/min	BHP max BHP	Ø Shaft Inches
58.38	1025	49.95	2-7/16"

**Operating data:**

o.v. ft/min	ptot In.W.G.	pstat In.W.G.	pdyn In.W.G.	tip speed ft/min	RPM 1/min	η stat. %	fan BHP BHP	P min BHP
3317.6	2.61	1.93	0.68	3661.1	564	46.6	14.96	16.76

**Total Sound Power Level Lw4 inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw4 tot [db]
Lwoct4 [dB]	100	94	91	90	86	83	80	75	102

**Total Sound Power Level LwA4 (filter A) inside the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA4 tot[dBA]
LwA4 oct [dBA]	74	78	82	87	86	84	81	74	92

**Total Sound Power Level Lw6d outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw6d tot[dB]
Lwoct6d [dB]	94	91	90	90	86	83	80	75	98

**Total Sound Power Level LwA6d (filter A) outside the termination of the outlet duct, per octave band:**

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA6d tot[dBA]
LwA6d oct [dBA]	68	75	82	87	86	84	81	74	92

**LwA4 tot [dBA] = LwA6d tot [dBA] = LwA7 tot [dBA]**

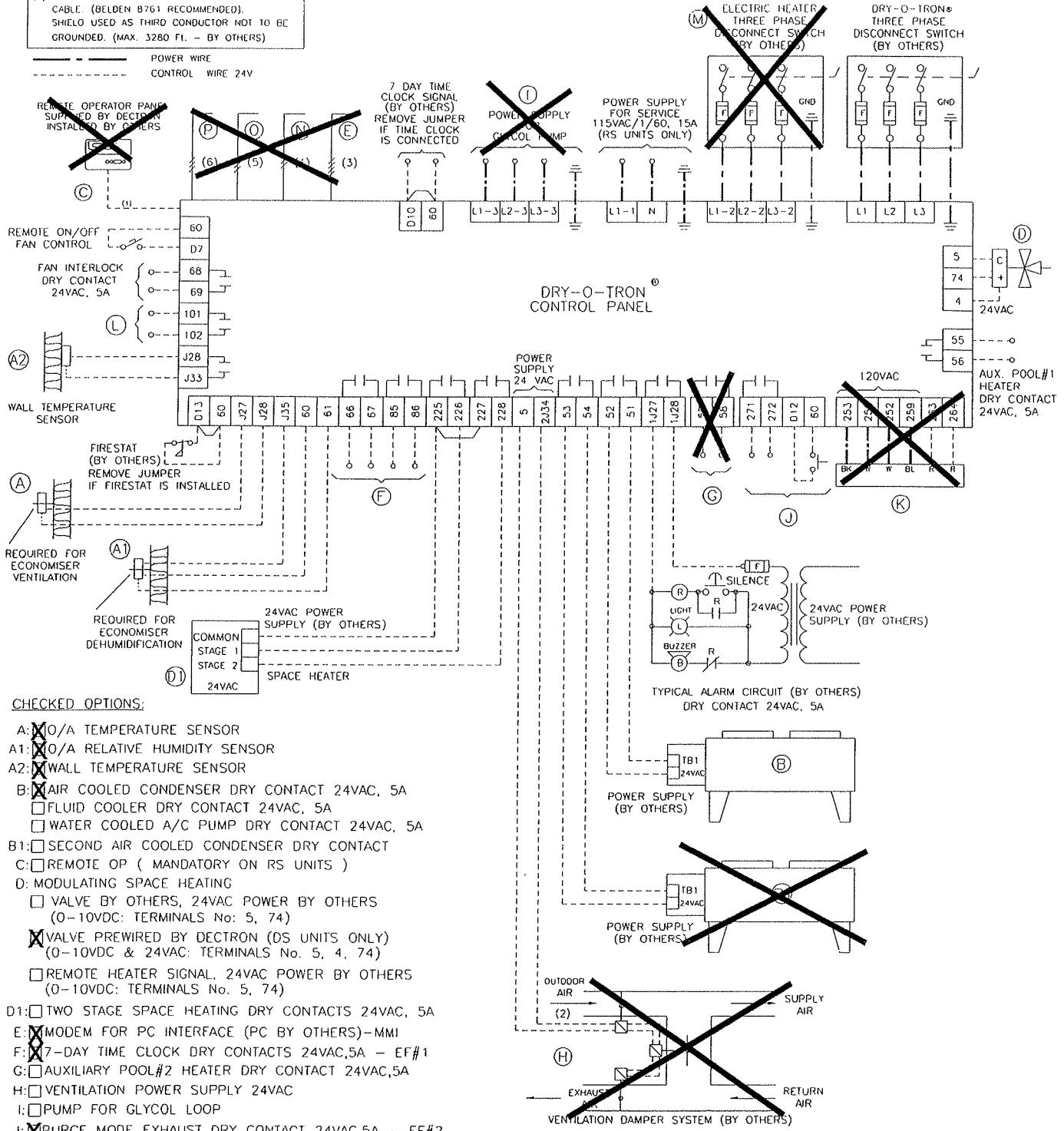
Power rating (BHP) does not include drive losses

Performance ratings do not include the effects of appurtenances in the airstream.

- CONTROL WIRE SIZE MIN. 20 AWG. EXCEPT:
- (1) 4 WIRE SHIELDED CABLE. MINIMUM 18 GAUGE (MAX. 3280 FL. - BY OTHERS)
  - (2) WIRE SIZE 16 AWG.
  - (3) 4 WIRE PHONE CABLE.
  - (4) 2 CONDUCTOR TWISTED PAIR RS-485 CABLE. ALPHA CABLE Co. 6222C OR BELDEN 3106A RECOMMENDED. (MAX. 3280 FL. - BY OTHERS) SHIELD TO BE GROUNDED AT ONE END ONLY.
  - (5) WIRING BY BMS CONTRACTOR (SHALL COMPLY WITH ECHELON CORPORATION GUIDELINES)
  - (6) SHIELDED 2 CONDUCTOR TWISTED PAIR RS-485 CABLE. (BELDEN B761 RECOMMENDED). SHIELD USED AS THIRD CONDUCTOR NOT TO BE GROUNDED. (MAX. 3280 FL. - BY OTHERS)

SEE TECHNICAL SPECIFICATIONS FOR MINIMUM AMPACITY AND MAXIMUM MAIN FUSE

# PAU-4



**CHECKED OPTIONS:**

- A:  O/A TEMPERATURE SENSOR
- A1:  O/A RELATIVE HUMIDITY SENSOR
- A2:  WALL TEMPERATURE SENSOR
- B:  AIR COOLED CONDENSER DRY CONTACT 24VAC, 5A
  - FLUID COOLER DRY CONTACT 24VAC, 5A
  - WATER COOLED A/C PUMP DRY CONTACT 24VAC, 5A
- B1:  SECOND AIR COOLED CONDENSER DRY CONTACT
- C:  REMOTE OP ( MANDATORY ON RS UNITS )
- D: MODULATING SPACE HEATING
  - VALVE BY OTHERS, 24VAC POWER BY OTHERS (0-10VDC: TERMINALS No. 5, 74)
  - VALVE PREWIRED BY DECTRON (DS UNITS ONLY) (0-10VDC & 24VAC: TERMINALS No. 5, 4, 74)
  - REMOTE HEATER SIGNAL, 24VAC POWER BY OTHERS (0-10VDC: TERMINALS No. 5, 74)
- D1:  TWO STAGE SPACE HEATING DRY CONTACTS 24VAC, 5A
- E:  MODEM FOR PC INTERFACE (PC BY OTHERS)-MMI
- F:  7-DAY TIME CLOCK DRY CONTACTS 24VAC,5A - EF#1
- G:  AUXILIARY POOL#2 HEATER DRY CONTACT 24VAC,5A
- H:  VENTILATION POWER SUPPLY 24VAC
- I:  PUMP FOR GLYCOL LOOP
- J:  PURGE MODE EXHAUST DRY CONTACT 24VAC,5A - EF#2 AND REMOTE PUSH BUTTON (BY OTHERS)
- K:  REMOTE GAS BOILER
- L:  DIRTY FILTER ALARM DRY CONTACT 24VAC,5A
- M:  UNIT MOUNTED ELECTRIC HEATER WITH SEPARATE POWER CONNECTION
- N:  MODBUS™ INTERFACE
- O:  LONWORKS® INTERFACE
- P:  BACnet™ INTERFACE



# DRY-O-TRON®

## Load Summary and DRY-O-TRON® Selection

8/28/2003

Prepared by: Michael Keller B.Sc. E. Eng.

Project: U of MO Aquatic Center Competition Pool  
 Room Temperature: 82 °F DB  
 Relative Humidity Range: Active : 54 % Unoccupied : 50 %  
 Active Hours: 14  
 Outdoor Conditions for: Columbia, MO  
 Summer Design: 95 °F DB 75 °F WB  
 Winter Design: -1 °F DB

Load Source	Load lb/h		Design Criteria			Primary Water Heater
	Active	Inactive				
Pool #1 (School/University)	672.6	352.5	12950 sq ft	82 °F	1	Dry-O-Tron
Pool #2 (Diving Well)	177.8	144.1	4390 sq ft	85 °F	0.65	Dry-O-Tron
Pool #3 (Whirlpool/Spa)	15.50	7.90	97 sq ft	104 °F	1	By Others
Pool #4						
Pool #5						
Outdoor Air	97.4		15600 CFM			N/A
Spectators	15.4		75@.205			N/A
Total Dehumidification load	244.7	126.1				

DRY-O-TRON® SELECTION Standard Unit PAU-5 DS-242-SS & Purge Design Day Run time: 73%  
 3 x DS 242 SS & Purge

### Air Cooled Condenser Auxiliary Heat Rejection & System Charge

Air on condenser: 100

Total heat rejection required: 817100 btu/h

Condenser Model	Voltage	MCA	Fuse/MOP	Qty of Fans	HP/Fan	Weight (lbs)	RPM
CID058	460/3/60	12.8	15	4	1.50	1781	1140

Total line length between outdoor air cooled condenser and the DRY-O-TRON (ft): 75

The condenser is: 30 ft Above the DRY-O-TRON  
 Line sizes to the condenser:  
 Standard Unit 1 5/8 Hot gas 1 3/8 Liquid  
 1 5/8 Hot gas 1 3/8 Liquid

Refrigerant type: R-22 Standard Unit  
 Factory Charge (lbs): 235  
 System Charge (lbs): 620

Field Charge by installing contractor (lbs): 385

### Notes:

- 1) Ensure there is clearance around the perimeter of the condenser equal to its width
- 2) Do not deviate from the recommended line sizes to the outdoor condenser.
- 3) Multiple fan units have ambient thermostat (factory supplied) controlled fan cycling kits.
- 4) Contactor and 24 volt transformer included.
- 5) Ensure traps are installed at all elevation changes and every 20' of riser.
- 6) A separate power supply is required to the outdoor air cooled condenser.
- 7) Disconnect by others

Software version: 2.0.1

USA 10935 Crabapple Road Suite202B Roswell, GA 30075 Tel: (770) 649-0102 Fax: (770) 649-0243  
 Canada 4300 Poirier Blvd., Montreal, QC H4R 2C5 Tel: (514) 334-9609 Fax: (514) 334-9184

## PAU-5 Winter SS Performance Oct 21 2003

PAU-5 Winter

OA Winter

PRG:cWATERH \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-21-2003  
- RATING -  
CFM 3900 INSIDE COEFF(Hi) = 477.2  
EDB -1.00 OUTSIDE COEFF(Ho) = 17.8  
LDB 43.80  
- - THERMAL COND(k) = 0.273  
SENS HT 189500 VIS(CENTIPOISE) = 3.61  
EWT/LWT 52.6 / 44.8 SP. HEAT = 0.85  
GPM 54.0 FREEZE POINT = -2.9 DENSITY = 65.50  
WV 4.6 REYNOLDS NUMBER = 5202  
FPD,PSI 4.4 HT.TRANSFER RATE = 11.15  
NO. CIR 19 LOG MEAN TEMP = 22.42  
FV 591.2 FPI = 10  
APD 0.81 ROW = 6  
FH = 23.750 FL = 40.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 6.60 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 19 - 6 - 10 - 40.0 CONN. SIZE = 2.125

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410\*\*\*  
Print this screen? (Y/N) >

EA Winter

PRG:cWATERC \*\*\*\*\*RefPlus Inc.\*\*\*\*\* 10-21-2003  
- RATING -  
CFM 4100 INSIDE COEFF(Hi) = 451.5  
EDB/EWB 82.0 / 70.0 OUTSIDE COEFF(Ho) = 16.1  
LDB/LWB 56.6 / 56.0 WET OUTSIDE COEFF(Ho) = 16.1  
MBH 188.29 THERMAL COND(k) = 0.273  
MSH 112.99 VIS(CENTIPOISE) = 3.67  
EWT/LWT 44.8 / 52.6 SP. HEAT = 0.85  
GPM 54.0 FREEZE POINT = -2.9 DENSITY = 65.51  
WV 4.6 REYNOLDS NUMBER = 5143  
FPD,PSI 6.4 HT.TRANSFER RATE = 10.30  
NO. CIR 19 LOG MEAN TEMP = 19.29  
FV 497.2 FPI = 10  
APD 0.80 ROW = 6  
FH = 47.500 FL = 25.000 FLUID = EG % CONC. = 35 FTYPE = 12 ALTD = 0  
F.A. = 8.25 F.MAT = AL F.THK = .0060 T.MAT = CU T.THK = .025 FFO = .0000 FFI = .0000

COIL MODEL: WEC - 38 - 6 - 10 - 25.0 CONN. SIZE = 2.125

\*\*\* PROGRAM DESIGNED IN ACCORDANCE WITH ARI Std.-410 ; APPLIES WHEN EDB >=35 \*\*\*  
Print this screen? (Y/N) >

# PAU-5



## Supply Fan @ 3.0" ESP (30 HP)

Model/size: ATZAF 32-32  
 Max fan rev.: 1700 RPM  
 Max. fan abs. BHP: 66.5 BHP  
 Moment of inertia: 232.00 lb ft<sup>2</sup>

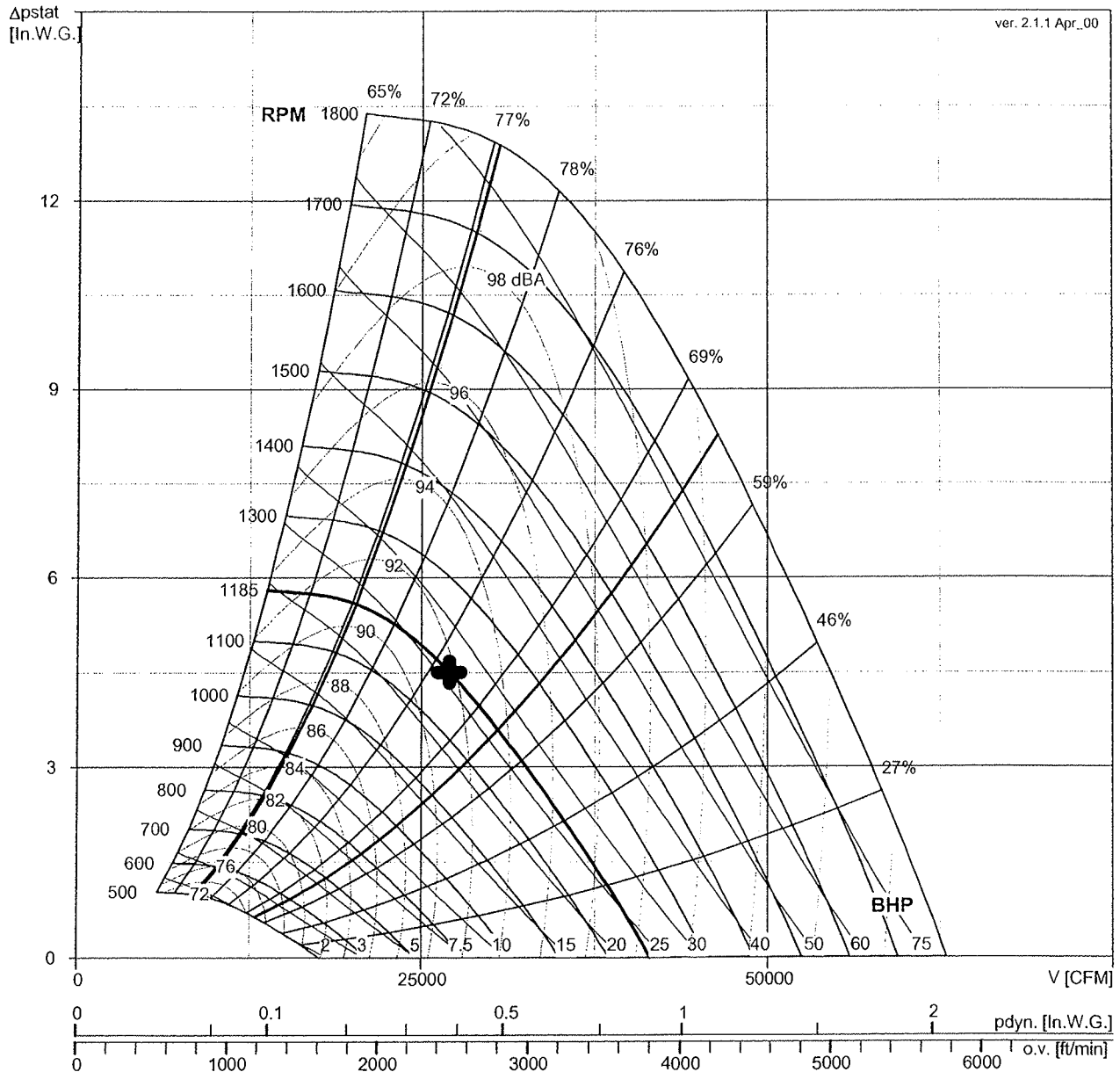
Fan working condition: Free inlet- Ducted outlet

Volume: 27000 CFM  
 Stat. pressure: 4.50 In.W.G.  
 Abs. shaft fan BHP: 26.07 BHP  
 Stat. Efficiency: 73.5 %  
 Temperature: 68.0 °F  
 Elevation: 0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft

Fan plot condition: ATZAF 32-32 T2 Free inlet- Ducted outlet

LwA4;7: A-weighted Sound Power Level inside the fan outlet duct and at fan inlet.



Power rating (BHP) does not include drive losses  
 Performance ratings do not include the effects of appurtenances in the airstream.

3.04.01

# PAU-5

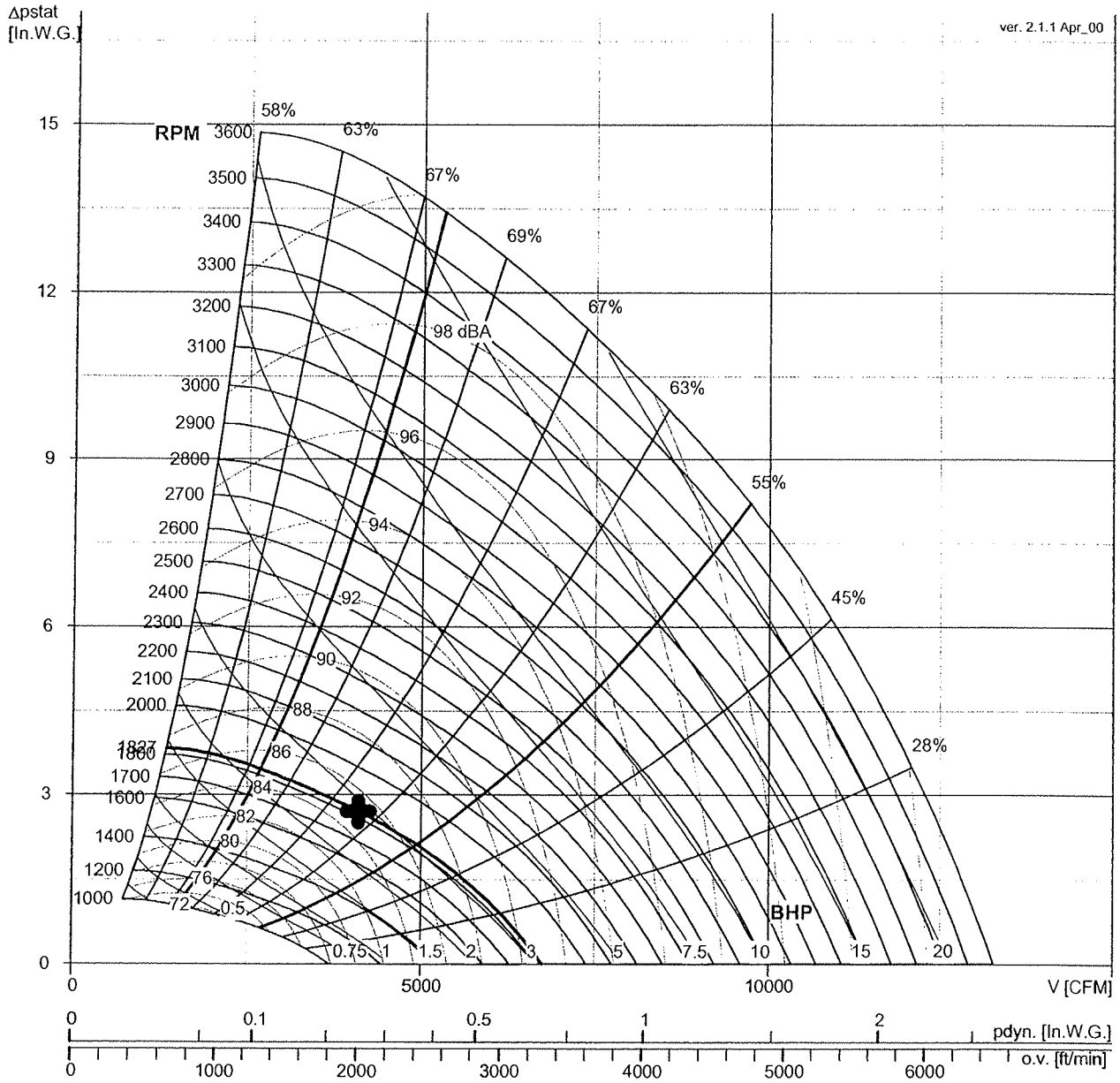


## ExFan1 Min Exhaust @ 1.5" ESP (5 HP)

Model/size: ATZAF 15-15  
 Max fan rev.: 3500 RPM  
 Max. fan abs. BHP: 15.0 BHP  
 Moment of inertia: 10.50 lb ft<sup>2</sup>

Fan working condition: Free inlet- Ducted outlet  
 Volume: 4100 CFM  
 Stat. pressure: 2.70 In.W.G.  
 Abs. shaft fan BHP: 2.81 BHP  
 Stat. Efficiency: 62.2 %  
 Temperature: 68.0 °F  
 Elevation: 0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft  
 Fan plot condition: ATZAF 15-15 T2 Free inlet- Ducted outlet  
 LwA4;7: A-weighted Sound Power Level inside the fan outlet duct and at fan inlet.



Power rating (BHP) does not include drive losses  
 Performance ratings do not include the effects of appurtenances in the airstream.

# PAU-5



## ExFan2 Purge @ 1.5" ESP (20 HP)

Model/size: ATLI 25 - 25  
 Max fan rev.: 1025 RPM  
 Max. fan abs. BHP: 50.0 BHP  
 Moment of inertia: 58.38 lb ft<sup>2</sup>

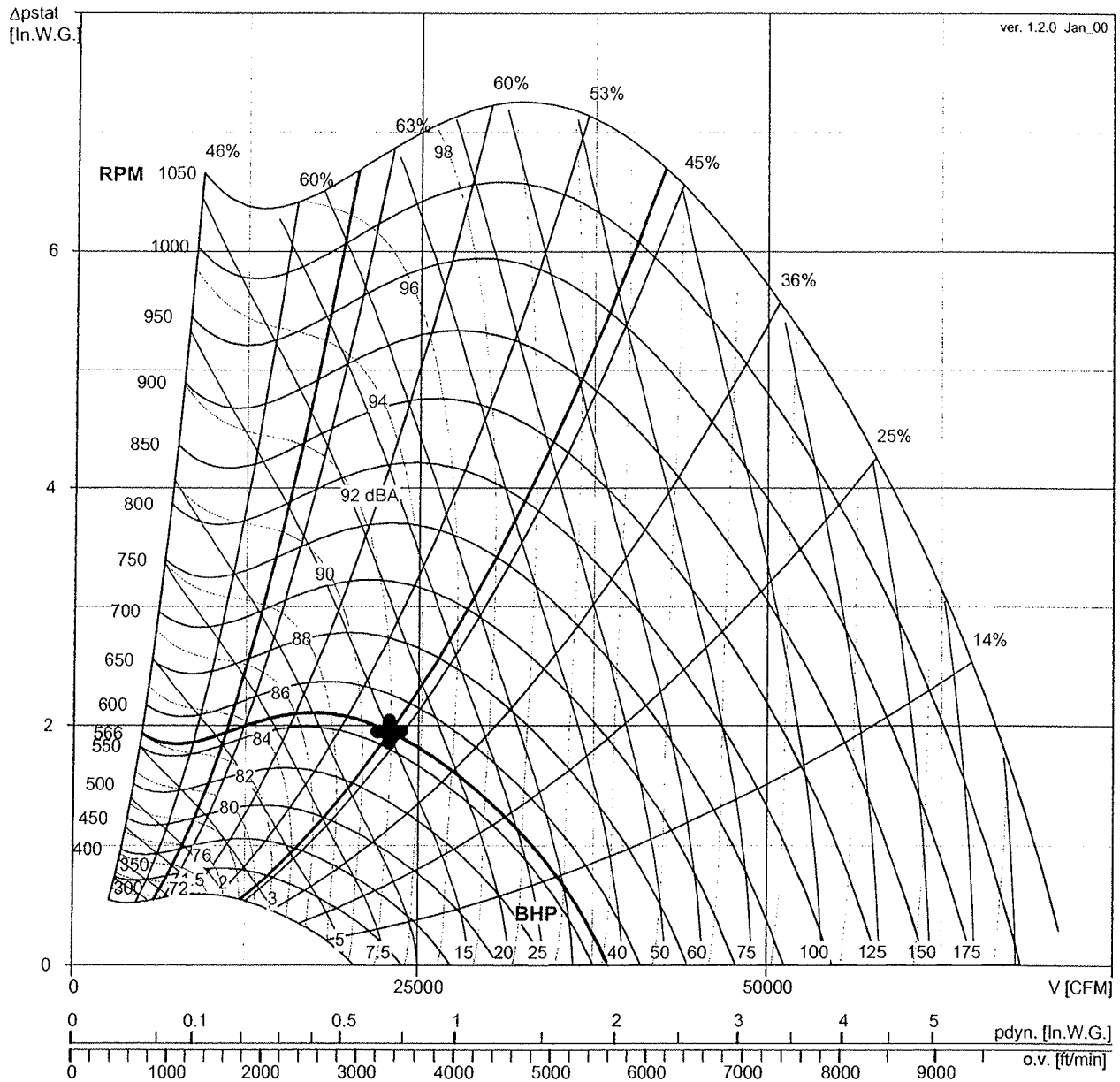
**Fan working condition: Free inlet- Ducted outlet**

Volume: 22900 CFM  
 Stat. pressure: 1.95 In.W.G.  
 Abs. shaft fan BHP: 15.05 BHP  
 Stat. Efficiency: 46.8 %  
 Temperature: 68.0 °F  
 Elevation: 0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft

Fan plot condition: ATLI 25 - 25 T2 Free inlet- Ducted outlet

LwA4;7: A-weighted Sound Power Level inside the fan outlet duct and at fan inlet.



Power rating (BHP) does not include drive losses

Performance ratings do not include the effects of appurtenances in the airstream.

3.04.01

**SUPPLY AIR**

BLOWER ORIENTATION (FACING LEFT HAND SIDE)	ROTATION	CHECK BOX
	C.W.	62
HORIZ -A-	C.C.W.	46
	<input checked="" type="checkbox"/>	

PIPE CONNECTIONS REF.

1: POOL  
3: HOT WATER COIL

2: AIR COOLED A/C  
4: DRAIN

**REVISION DETAIL**

NO:	DATE:	DESCRIPTION:
1	AUG.28/03	DWG REVISED
2	OCT.15/03	CONNECTIONS ON LEFT SIDE
-	-	-
-	-	-
-	-	-

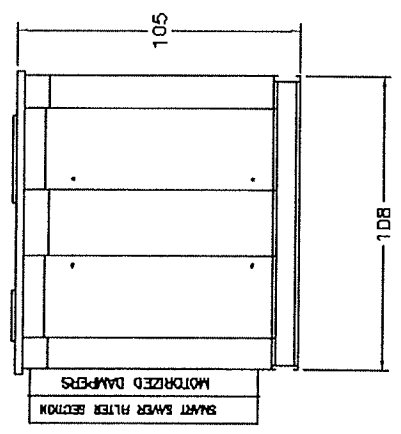
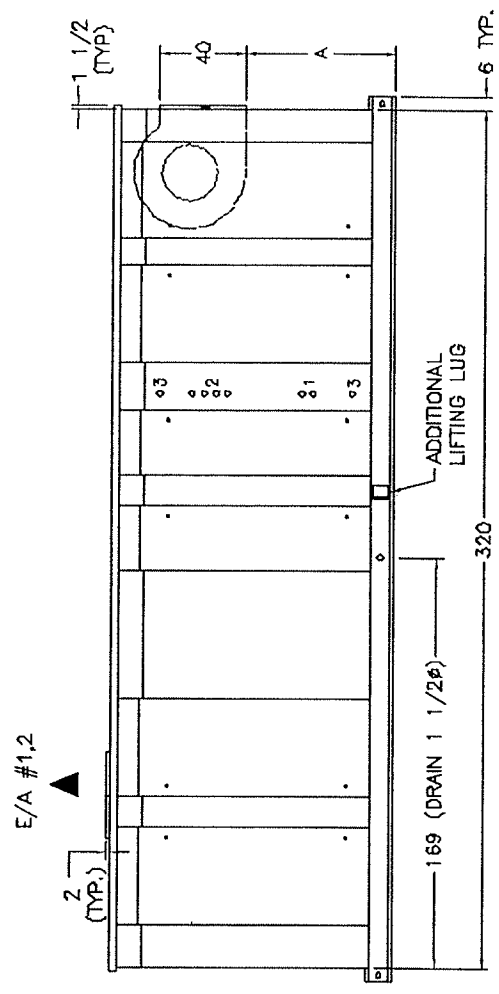
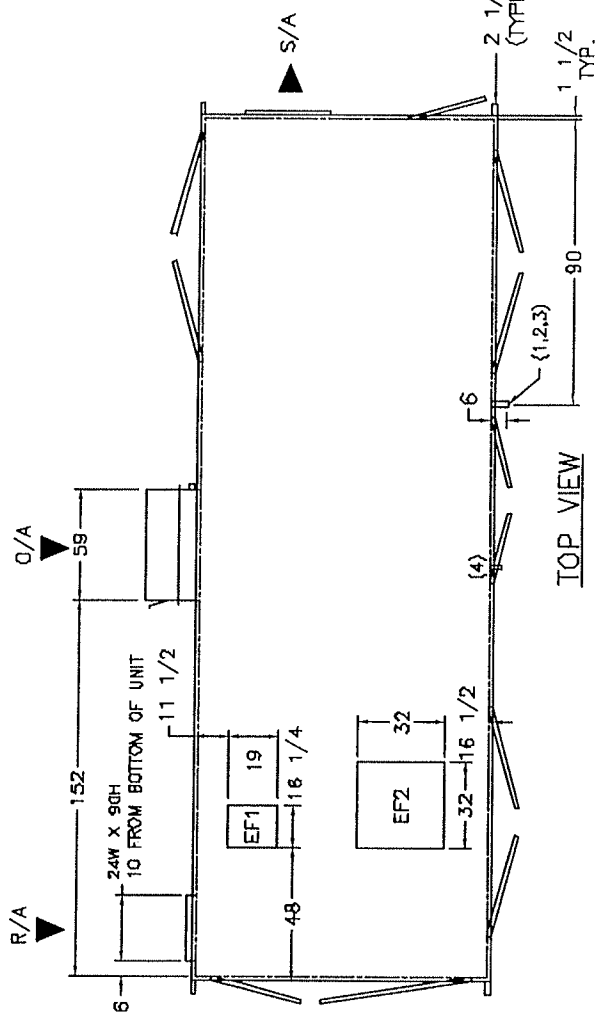
**DRAWING DETAIL**

DESIGN PAR: H.X.
DRAWN BY: H.X.
DATE: 22 APR./03
VERIFIED BY: N.T.S.
CHECKED BY: PAU-5
JOB NO: PAU-5
APPROXIMATE WEIGHT: 18,500 lbs. ±10%
PODS APPROXIMATE:



NO. DESIGN: DS-NM-242-319 AE REV: 2  
 DWG. NO.:  
 TITLE: MODEL DS-242  
 H.A.D.(CCW), R.S.A.R., R.S.O.A., T.E.A.  
 SMART SAVER, PURGE, SPRING ISOLATED  
 SUPPLY FAN IN DS-282 ENCLOSURE

NOTES: ALL DIMENSIONS ARE IN INCHES.



FRONT VIEW

LEFT HAND SIDE VIEW

END VIEW

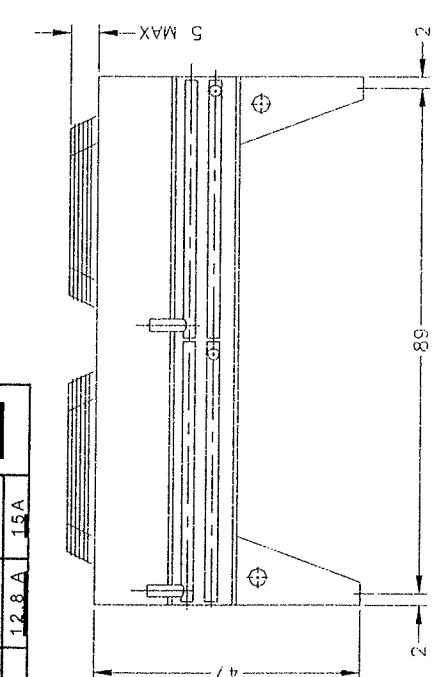
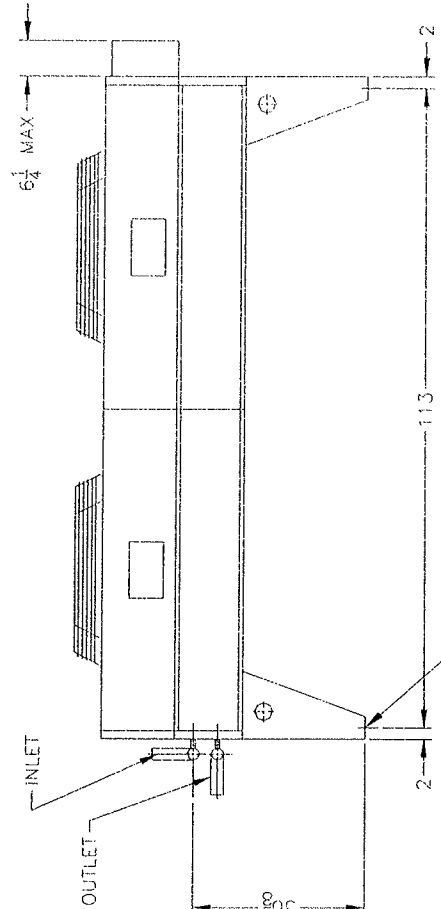
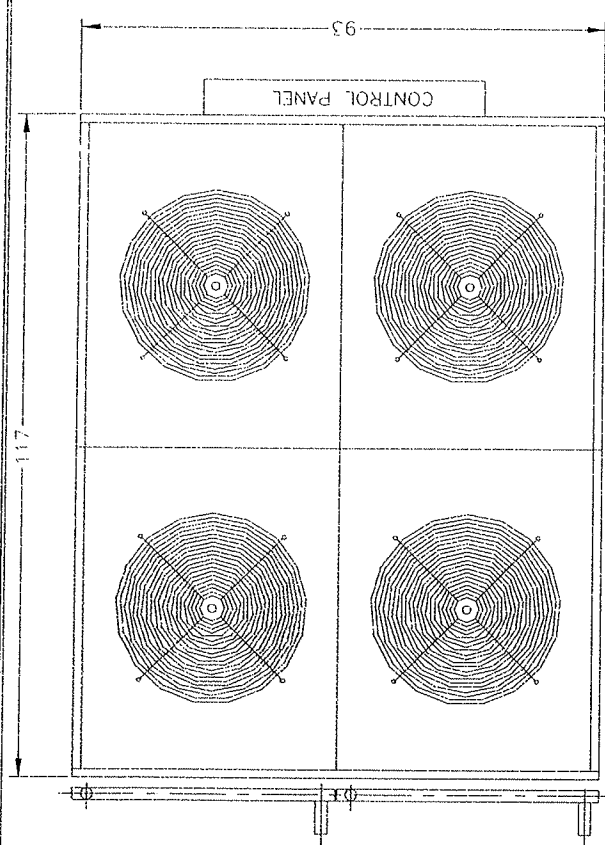
# PAU-5

MODEL	CONNECTION INCHES		REFRIGERANT CHARGE LBS R22		SHIPPING WEIGHT LBS	HP
	INLET	OUTLET	SUMMER	WINTER		
CLD042	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CLD049	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CLD053	(2) 1 5/8	(2) 1 3/8	35	115	1781	
CLD056	(2) 1 5/8	(2) 1 3/8	47	153	1882	1
CLD060	(2) 1 5/8	(2) 1 3/8	47	153	1934	
CL8036	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CL8047	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CL8053	(2) 1 5/8	(2) 1 3/8	47	153	1882	
CLD046	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CID054	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CID058	(2) 1 5/8	(2) 1 3/8	35	115	1781	
CID064	(2) 1 5/8	(2) 1 3/8	47	153	1882	1 1/2
CID068	(2) 1 5/8	(2) 1 3/8	47	153	1934	
CH8040	(2) 1 3/8	(2) 1 3/8	23	75	1625	
CH8051	(2) 1 5/8	(2) 1 3/8	35	115	1792	
CH8058	(2) 1 5/8	(2) 1 3/8	47	153	1882	

CONTROL:

<input checked="" type="checkbox"/>	24 V
<input type="checkbox"/>	208-240 V
<input type="checkbox"/>	120 V

VOLTAGE	AMP	FUSE	HP
208-240/3/60	18.7 A	20A	1
600/3/60	6.8 A	15A	
480/3/60	8.5 A	15A	
208-240/3/60	25.5 A	30A	
600/3/60	9.8 A	15A	1 1/2
<input checked="" type="checkbox"/> 480/3/60	12.8 A	15A	



**REPLUS**  
 1385A De Couombe  
 5487 Parker, P.O.  
 TEL: (514) 641-2855  
 FAX: (514) 641-4554

CONDENSER (2 x 2)  
 SEE TABLE

UNLESS OTHERWISE SPECIFIED:  
 DIMENSIONS ARE IN INCHES  
 TOLERANCES DEC., STD. ANG. 2°

DATE: 97-11-18  
 CHECK BY: Y. CLOUTIER

REV	DATE	BY	DESCRIPTION

ENG NO  
**CL10006**  
 REV

- ◆ If the room relative humidity climbs by an additional 5%RH or if high limit of 60% RH is reached, compressor #2 starts to operate as well. The unit is in "second stage dehumidification and hot gas reheat mode".

### **Pool water heating mode**

Pool water heating mode occurs when the pool water temperature drops below setpoint.

- ◆ If the compressor is already operating in dehumidification mode or cooling mode the compressor hot gas is used for water heating.
- ◆ If all room conditions are satisfied or there is a call for second stage pool water heating, the microprocessor will send a signal to the auxiliary pool water heater to maintain water temperature.
- ◆ Watersmart design will ensure compressor operation in dehumidification mode and cooling mode is never interrupted by lack of water flow to the unit.
- ◆ Should water flow be interrupted, the microprocessor will lock out water heating mode and display 'low water flow' message on the operator panel. All other modes of operation will operate normally.

### **Cooling mode**

Cooling mode occurs when the space temperature is above setpoint.

- ◆ The outdoor air sensor verifies if economizer cooling is possible.
- ◆ If outdoor air is not suitable for economizer cooling, compressor #1 starts to operate in "first stage cooling mode".
- ◆ If the room temperature continues to climb by 1F, compressor #2 starts to operate in "second stage cooling mode".

The outdoor air-cooled condenser rejects compressors' total heat of rejection as required.

### **Economizer Mode**

Economizer mode will operate whenever outdoor conditions permit and override compressor operation.

- ◆ If cooling is calling, the microprocessor will verify that the outdoor temperature is suitable. If yes and the outdoor humidity level is neutral to the space, the unit will operate in economizer cooling mode.
- ◆ If dehumidification is calling, the microprocessor will verify that the outdoor moisture level is suitable. If yes and the outdoor temperature is neutral to the space, the unit will operate in economizer dehumidification.
- ◆ During economizer mode the motorized O/A damper opens to 100% and R/A dampers (evaporator face and bypass damper) fully close. Supply fan and exhaust fans (EF1 & EF2) ventilate the space with 100% outdoor air.

### **Space heating mode**

Heating mode occurs when the space temperature drops below setpoint.

- ◆ If the room temperature drops below setpoint the DRY-O-TRON®'s microprocessor will send a signal to a modulating space heating coil (factory mounted) to maintain space temperature.



## **PDU-3 unit**

### **Supply air blower**

Blower operation is continuous. It can be remotely controlled by a BMS signal.

Blower stops and all motorized dampers close on:

- power failure
- firestat alarm
- freezestat alarm
- remote off control (manual or from BMS)

### **Exhaust air blowers (EF1, EF2 & EF3)**

Blowers can be unit mounted or remote.

EF1 blower operation is continuous or can be controlled through the microprocessor in the DRY-O-TRON<sup>®</sup> or by an occupied unoccupied signal from the BMS or a seven day timeclock. EF1 exhausts 10% more air than is introduced through the outdoor air opening at minimum setpoint to maintain a negative space pressure.

EF2 operates only on call for purge mode or economizer mode.

EF3 operates on call for swim meet mode, purge mode or economizer mode.

Blowers stop and all motorized dampers close on:

- power failure
- firestat alarm
- freezestat alarm
- remote off control (manual or from BMS)

### **Outdoor air damper**

Damper is normally closed (unoccupied mode).

On occupied signal from the BMS or seven day time clock the damper opens to the minimum setpoint. Outdoor air is introduced to meet the local code requirements.

On purge mode signal the damper opens fully to allow 100% outdoor air into the DRY-O-TRON<sup>®</sup>.

All motorized dampers close on supply air blower stop.

### **Dehumidification mode**

Dehumidification mode occurs when the room relative humidity rises above setpoint (i.e. 50%RH).

- ◆ The outdoor air sensors on Supervisaire controller (temperature and %RH) will verify if economizer dehumidification is possible.
- ◆ If outdoor air is not suitable for economizer operation, compressor #1 starts to operate in "first stage dehumidification and hot gas reheat mode". The hot gas reheat coil is energized.

## Sequence of operation for DS/RS 2 compressor unit with purge mode configuration

- ◆ Unit mounted heating coil Freeze protection mode. If heating coil average leaving air temperature falls below 45°F (adjustable) the blowers shut down, all dampers close and control valves should fail to full open.

### **Purge Mode**

Purge mode occurs on a call for purge mode from DRY-O-TRON® operator panel or remote push button (by others) momentary signal. This timer operated mode (2-20 minutes) is intended to ventilate the space with one complete air change and then automatically resume normal operation.

- ◆ DRY-O-TRON® compressor(s) are stopped.
- ◆ Face and bypass dampers on evaporator coil close fully.
- ◆ Outdoor air damper opens fully to allow 100% outdoor air into the DRY-O-TRON®.
- ◆ EF1, EF2 & EF3 operate to evacuate maximum airflow from the space.
- ◆ The space heating coil will temper the supply air as required.

### **Smart Saver Heat Recovery**

During occupied period, the outdoor air dampers open to minimum position or swim meet mode position. Exhaust air blower (EF1 or EF3) is activated. Heat contained in the exhaust air is transferred to the incoming outdoor air via the air-to-refrigerant heat exchangers.

During unoccupied period, the outdoor air dampers and exhaust air backdraft dampers stay in closed position.

### **Condensation Prevention Cold-Wall Temperature**

- ◆ When the temperature of the interior surface at the wall sensor drops to within 5°F of the dew point temperature of the space air, the relative humidity setpoint is offset downward. This condition causes the dehumidifier system to activate humidity control lowering the space dew point and hinders the formation of condensation on the cold wall surfaces.

### 1.3 Submittals

- .1 Submittal package shall include : performance and technical data, dimension drawing, field wiring, operating sequence, general unit specifications, corrosion coating specifications, microprocessor controls, accessories, general system design requirements, service access requirements and warranty.
- .2 **Basis of unit selection and performance with supporting documentation to be furnished with bid. Guaranteed maximum annual operating cost to be supplied with bid.**
- .3 A copy of a similarly sized unit's actual quality control and testing report to be submitted for the engineers review.

### 1.4 Operating and Maintenance Data.

- .1 Electrical wiring diagrams, installation and maintenance instructions and an owner's manual shall be supplied with each unit.

## 2. Products

### 2.1 General

- .1 The dehumidifiers shall be single package units. Each unit shall include compressor(s), evaporator (dehumidifying coil), condenser (air reheat coil), water heater(s), supply and exhaust air blower(s), blower motor(s), motor starters and controls in one complete enclosure All controls shall be via fully programmable and fully self diagnostic microprocessor.
- .2 The unit shall be designed for indoor installation.
- .3 Entire unit shall be ETL listed or CSA certified and shall comply with BOCA code M-401.1 and M-402.1. Units with listed components only shall not be acceptable.
- .4 The unit shall be configured with the ability for 100% purge mode by outdoor air introduction and exhaust.
- .5 Exhaust fan(s) shall be unit mounted and sized to maintain the facility at negative pressure as prescribed by ASHRAE.
- .6 Unit shall be supplied with integral space heating coil sized to meet the skin losses and outdoor air heating loads.

## 2.3 Cabinet

- .1 The base frame shall be constructed of welded 'C channel'. Bolted construction shall not be acceptable. The welds shall be ground smooth, phosphate degreased and painted with 2 coats of epoxy primer and 2 coats of enamel paint.
- .2 The base shall be 12 gauge hot dipped zinc coated sheet metal. The zinc coating shall be smoothed to a paint ready satin coat finish. Cold rolled steel shall not be acceptable. The base plates shall be bent to wrap over the 'C channel' where it is to be welded to the frame. The entire base shall be phosphate degreased and painted with 2 coats of self priming enamel paint.
- .3 The units shall be constructed of 14-gauge hot dipped zinc coated sheet metal. The zinc coating shall be smoothed to a paint ready satin coat finish. All metal to be phosphate degreased and then painted with 2 coats of self priming enamel paint.
- .4 All doors and service panels to be hinged to provide access to all internal parts from both sides and in both sections. Slide in doors shall no be acceptable. Hinges to be 11 gauge stainless steel with ¼" permanent pins bolted to the unit and doors. The fasteners shall be compression type that secure the door tightly to the enclosure.
- .5 Each unit shall have a built-in electrical control panel in a separate compartment in order not to disturb the air flow within the dehumidifier during electrical servicing. All electrical components shall be mounted on a 14 gauge painted subpanel. Direct mounting of components to the partition wall shall not be acceptable.
- .6 The unit shall have a built-in air filter rack with separate hinged access door with compression fasteners. The filter rack shall be minimum 18" deep.
- .7 The unit shall be equipped with an opening suitable for connection of a duct to admit outdoor air to comply with ASHRAE Ventilation Standard 62-1989. Outdoor air intake assembly shall be welded to become an integral part of the enclosure. The section shall be painted internally and externally. It shall have a built in air filter rack with separate hinged access door and motorized damper controlled by seven day time clock. Outdoor air shall be admitted between the evaporator and condenser coils.
- .8 All components not requiring welding shall use ¼" zinc coated steel bolts fastened to permanently enclosure mounted nuts. Loose bolts and sheet metal screws shall not be acceptable.
- .9 All walk-in access doors shall have 260 Ventlok Latch. This latch is designed for walk-in access doors and can be operated from both inside and outside the enclosure.

## 2.4 Insulation

- .1 Entire coil section shall be insulated to prevent condensation with 1/2 inch thick fiberglass duct liner insulation, approved for 250 °F operating temperature and up to

## 2.7 Drain Pan

- .1 Each unit shall be equipped with a sloped non-trapping drain pan under the entire evaporator coil and prevent condensate carryover. Flat drain pans susceptible to water pooling and subsequent bacteria growth shall not be acceptable.
- .2 The drain pan shall be double walled with insulation and constructed of 20 gauge hot dipped zinc coated corrosion resistant sheet metal and painted after fabrication with a protective coating (Rust-Oleum High Performance Epoxy 9100 System) providing a chlorine and pool chemistry resistant finish.
- .3 The drain pan will be complete with a recessed side drain for minimum condensate collection in pan. Drain connection shall be suitable for 1 1/2 inch P-trap connection (by others).

## 2.8 Blower(s)

### 2.8.1 Supply Air Blower

- .1 Shall be double width, double inlet, air foil and backward curved blades dynamically and statically balanced and tested, mounted on a solid steel coated shaft.
- .2 Shall have a galvanized steel wheel and galvanized steel casing painted with a baked epoxy finish.
- .3 Bearings shall be grease-lubricated, self-aligning for 200,000 hours average L-50 life. Bearings shall have extended grease lines to be accessible from outside.
- .4 Shall bear the AMCA certified ratings Air Performance label.
- .5 Supply air blower, motor and drive shall be internally spring isolated on a structural steel base. Restrained isolators shall have 1 inch deflection. Blower shall be attached to unit casing by flexible canvas duct.

### 2.8.2 Exhaust Blower(s)

- .1 Shall be double width, double inlet, air foil and backward curved blades dynamically and statically balanced and tested, mounted on a solid steel coated shaft.
- .2 Shall have a galvanized steel wheel and galvanized steel casing painted with a baked epoxy finish.
- .3 Bearings shall be grease-lubricated, self-aligning for 200,000 hours average L-50 life. Bearings shall have extended grease lines to be accessible from outside.

for easy connection. The internal water circuit of the unit shall be smooth, valveless, and designed for constant water flow.

#### 2.12 Compressor(s)

- .1 Shall be a heavy duty semi-hermetic reciprocating compressors, serviceable type, suction gas cooled, suitable for refrigerant R-22, equipped with stainless steel discus valves, internal solid state thermal protection sensor, service valves, vibration isolators, easily removable crankcase heater for liquid migration protection, spring mounted, muffler plate on the discharge valve, oil pump for forced lubrication, oil level sight glass, pump down cycle protection and oil failure protection.
- .2 Compressor manufacturer must have a wholesale outlet for replacement parts in the nearest major city.
- 3 Compressor(s) shall have an optional 4-year extended warranty underwritten by the manufacturer. Third party coverage shall not be acceptable

#### 2.13 Refrigeration Circuit

- .1 Shall have a replaceable core type liquid line filter drier with liquid and moisture indicator visible from outside the unit without removal of the access panel. Unit shall have a thermostatic expansion valve, a pump down solenoid valve and one manual valve to isolate filter drier for fast drier core replacement.
- .2 Tamper proof, hermetically sealed non-adjustable high and low pressure controls and refrigeration service valves shall be installed using Schraeder type valves.
- .3 Refrigeration service valves shall be located outside of the airstream.
- .4 Suction line shall be fully insulated with not less than 1/2 inch closed cell insulation.

#### 2.14 Control Panel

- .1 Shall be built-in within a separate compartment in order not to disturb the air flow during servicing.
- .2 All electrical components shall be mounted on a 14 gauge painted subpanel. Direct mounting of components to the partition wall shall not be acceptable.
- .3 Blower motor(s) and compressor(s) shall be controlled by contactors.
- .4 Blower motor(s) and compressor(s) shall be thermally protected.
- .5 Voltage monitor shall be provided to shut down electrical system to prevent damage in the event of temporary voltage fluctuation or phase loss. Voltage monitor shall be auto reset.

Manual reset required  
Blower on  
Lead lag on  
Compressor 1 pumpdown  
Compressor 2 pumpdown  
Please wait...compressor 1 will auto reset (high pressure, low pressure, overheat)  
A.S.C.T. 1 on  
Please wait...compressor 2 will auto reset (high pressure, low pressure, overheat)  
A.S.C.T. 2 on  
Ventilation on (units with no AC or in case of compressor failure)  
Economizer on for cooling and/or dehumidification  
Dehumidification on  
A/C on  
Oil return mode 1 on  
Oil return mode 2 on  
Aux. air heating on  
Evaporator damper closed  
Pool 1 heating on  
Pool 1 aux. on  
Pool 2 heating on  
Pool 2 aux. on  
Dehumidification call  
Air heating call  
Cooling call  
Pool 1 heating call  
Pool 2 heating call  
Occupied period  
Purge mode on  
Minimum exhaust blower on  
Maximum exhaust blower on  
Swim meet exhaust blower on (PAU-3)

#### Alarm Messages

Expansion module communication failure  
Humidity sensor fault  
Return air sensor fault  
Supply air sensor fault  
Evaporator 1 sensor fault  
Pool 1 in sensor fault  
Pool 1 out sensor fault  
Pool 1 leaving water too hot  
Discharge 1 sensor fault  
Outdoor temperature sensor fault  
Pool 2 in sensor fault  
Pool 2 out sensor fault  
Pool 2 leaving water too hot  
Evaporator 2 sensor fault

.4 All sensors shall be factory tested and calibrated. Easy-to-use field calibration capability shall be provided through the operator panel. Humidity sensor shall be corrosion resistant, especially suited for harsh exposure such as indoor pools and spas with chlorine containing environments.

.5 The control program shall be factory developed to user specification, factory tested and loaded into the controller. Through the operator panel, the user shall be able to set/perform the following functions:

- Compressor 1 auto/off mode
- Compressor 2 auto/off mode
- Blower auto/off mode
- Manual reset
- Change all humidity and temperature setpoints
- Disable or force occupied period
- Activate purge mode and adjust purge mode duration
- Service mode (password protected) for:
  - Heating / cooling deadband and differential
  - Sensor calibration
  - Economizer damper settings
  - Minimum damper setting
  - Evaporator damper setting

.6 The following features shall be preprogrammed and used when required:

Auto reset 3 times

High pressure, low pressure and compressor overheat faults shall automatically reset after the compressor has stopped for 5 minutes. A message shall be displayed at the operator indicating the reason. If the fault repeats 3 times, the compressor shall lock out on alarm.

Timed pumpdown

If pumpdown continues longer than the allotted time, the compressor shall stop.

Timed freezestat reset

Freezestat shall reset automatically when the coil temperature rises above setpoint and a predetermined time has elapsed.

Performance monitoring

The unit shall evaluate its own performance. If it is not satisfactory, an alarm shall be triggered and the fault shall be displayed at the operator panel.

Oil return mode

Unit shall recover migrated oil by operating in air conditioning mode at timed intervals.

Lead lag

On 2 compressor units, compressor starting order shall alternate to maintain equal run time.



0-1V, 0-10V, 0-20mA, 4-20mA

**DIGITAL INPUTS:**

14 optically-isolated digital inputs, 24Vac 50/60Hz or 24Vdc

4 optically-isolated digital inputs, 24Vac 50/60Hz or 24Vdc or 110/230Vac

**ANALOG OUTPUTS:**

6 optically-isolated 0-10V analogue outputs

**DIGITAL OUTPUTS:**

18 digital relay outputs (5 of which with switching contacts)

**INDEX OF PROTECTION:**

general: IP20, display side: IP55

**OPTIONS:**

A. Outdoor air temperature, wall temperature sensor, and outdoor air relative humidity sensors for duct/remote (mounting by others) shall be supplied to override dehumidification demand and/or enable the economizer mode when outdoor air conditions are suitable to maintain space temperature and relative humidity.

B. There shall be an optional Man Machine Interface (MMI), to access unit controls from a personal computer (PC By Others).

Accessible functions:

Sensor readings

Unit status messages

Unit alarm messages

Auto / off controls

Setpoints

Purge functions (if so equipped)

This option is dial up (modem) versions. Each unit has its own modem and dedicated phone line (by others).

Minimum System Requirements:

Windows 98

Microsoft Explorer 5.0

50 Mbytes of Hard Disk space

128 Mbytes of RAM

1 USB port available

1 COM port available

- .4 Unit shall include an oil separator package.
- .5 Hot gas lines shall be fully insulated with not less than 1/2 inch closed cell insulation. Units without insulated hot gas lines in the air stream shall not be acceptable.

#### 2.18.1 Air-Cooled Air Conditioning-Chilled Water Coil (3<sup>rd</sup> stage cooling) – PAU-3

- .1 Shall be factory installed and be one row deep with 1/2 inch OD, 0.025" thick wall seamless copper tubing mechanically expanded with maximum twelve copper fins per inch.
- .2 Minimum fin thickness of 0.008 in.
- .3 Water circuit to be designed for minimum 3.0 FPS and maximum 8 FPS to assure maximum heat transfer.
- .4 Coil shall have a 16-gauge copper casing and end plates.
- .5 Coil shall be factory tested at air pressures not less than 400 psig in a water bath.
- .6 Coil shall be HyPoxy® coated fins for maximum corrosion resistance. Untreated fin material shall not be acceptable. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance.
- .7 Chilled water flow shall be controlled by an ON-OFF 3 way valve (supplied by the unit manufacturer). This valve shall be controlled by the unit's control system.
- .8 Coil shall have an optional 9-year extended warranty underwritten by the manufacturer. Third party coverage shall not be acceptable.

#### 2.19 Hot Water Coil

- .1 Shall be factory installed and be one or two rows deep for variable heat transfer into the air with 1/2 inch OD, 0.025" thick wall seamless copper tubing mechanically expanded with maximum twelve aluminum fins per inch.
- .2 Minimum fin thickness of 0.006 in. Minimum tube thickness = 0.016 in.
- .3 Water circuit to be designed for minimum 3.0 FPS and maximum 8 FPS to assure maximum heat transfer.
- .4 Coil shall have a 16-gauge galvanized casing and end plates.
- .5 Coil shall be factory tested at air pressures not less than 400 psig in a water bath.

.2 Outdoor air Coil

- A. Shall not be less than six rows deep for maximum heat transfer into the air with 1/2 inch OD, 0.025" thick wall seamless copper tubing mechanically expanded with maximum ten aluminum fins per inch.
- B. Coil shall have a 16-gauge galvanized casing and end plates.
- C. Coil shall be factory tested at air pressures not less than 400 psig in a water bath.
- D. Shall have HyPoxy® coated fins. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance.
- E. Coil shall have an optional 9-year extended warranty underwritten by the manufacturer. Third party coverage shall not be acceptable.

.3 Glycol Circuit

Systems shall have pressurized expansion tank, a circulator pump with 304 stainless steel liquid handling components, high efficiency impeller and rugged ball bearings.

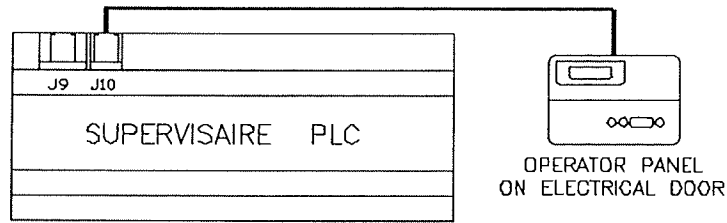


Coils: Fabricated from die-formed, collared, self-spacing **HyPoxy®** aluminium fins and seamless copper tubes, staggered in the direction of air flow. The **HyPoxy®** coils have a special **DRY-O-TRON®** property of accelerating the draining of entrained moisture and act as a resistant barrier for the aluminium fin surface, enhancing the performance and life of the coil.

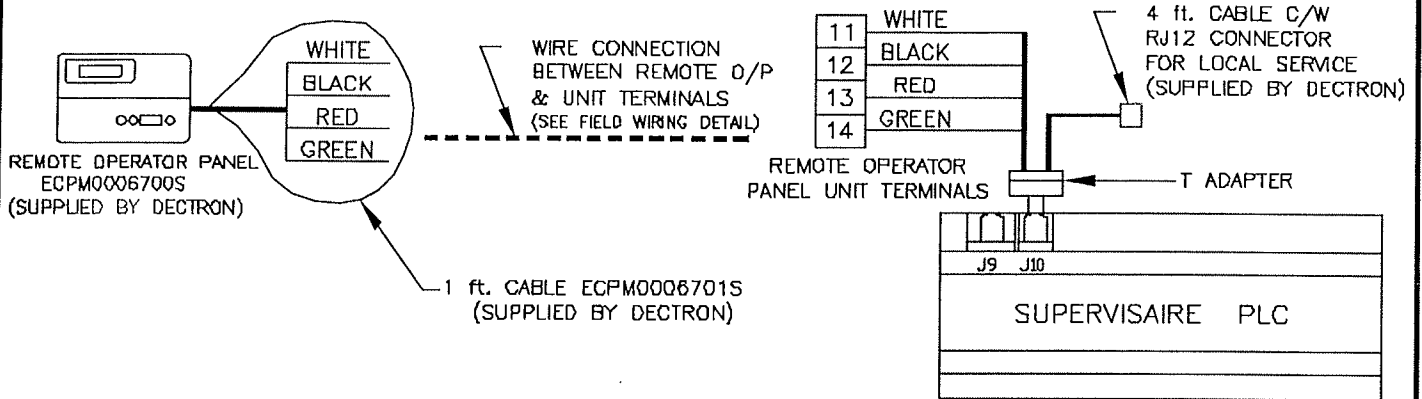
SUBSTRATE	ALUMINIUM
COATING TYPE	Proprietary (Epoxy based)
COATING WEIGHT	1.5 - 1.7 lbs/ream/side
COATING THICKNESS	2.0-2.5 microns/side
COLOR	Aqua
COATING APPLICATION	Permanently bonded with I.R. processing

CORROSION RESISTANCE	Reduced galvanic corrosion between copper and aluminium and reduced formation of white rust on fins	500 hours of salt spray as per ASTM B117/D1 654 at a rating of 9. Passes 500 hours humid age as per ASTM D2126
DIE WEAR	No accelerated die wear	Coating was specifically developed to exclude silica and silicates which are known to cause excessive die wear.
FLEXIBILITY AND ADHESION	Superior during fin formation	Passes a 0 T-BEND as per ASTM D4145. Passes Tape Adhesion Test ASTM D3359A. Passes Olsen Cup Testing.
HYDROPHILICITY (WETTABILITY)	Low angle of contact. No beading up of condensate which allows rapid sheeting off, of condensate	Contact angle initially 10-15° and after 30 cycles increases to 55-65° (1 cycle = 7 hours immersion in running water 17 hours heat at 220°F).
ODOR FORMATION CONTROL	Reduces the incidence of bacterial odor	Allows condensate to sheet off. It minimizes pooling which can promote odor-forming bacterial growth
MORE FINS PER UNIT LENGTH	Allows for more fins per unit length resulting in smaller and more efficient coils. Air efficiency and heat transfer are improved.	Minimized bridging of condensate allows for reduction of inter-fin spacing.
OTHER		Offers resistance to fin press oils and evaporation lubricants.

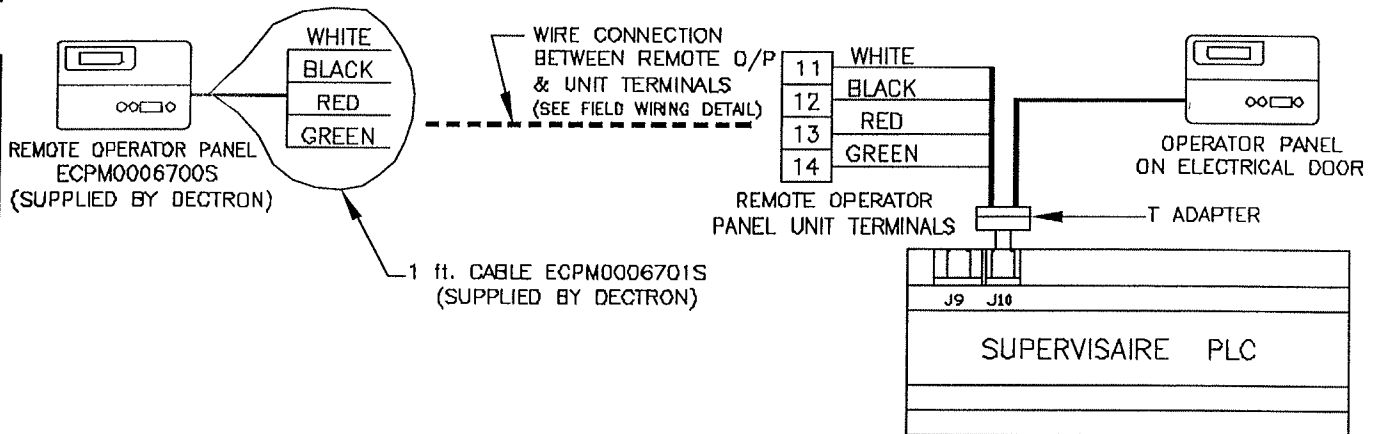
### 1) UNIT MOUNTED OPERATOR PANEL: STANDARD ON INDOOR UNITS



### 2) REMOTE OPERATOR PANEL: STANDARD ON OUTDOOR UNITS



### 3) UNIT MOUNTED & REMOTE OPERATOR PANEL OPTION

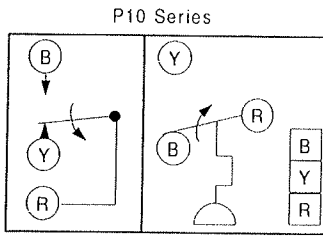


FOR CONNECTION USE WIRE CONNECTORS (BY OTHERS) { WHITE, BLACK, RED, GREEN } 4 WIRE, 18 GAUGE SHIELDED CABLE MAX. 3280 ft. (SUPPLIED BY OTHERS) { WHITE, BLACK, RED, GREEN } CONNECT TO UNIT TERMINALS

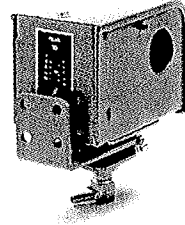
**FIELD WIRING DETAIL**

—	—	—	—	—	DESSINE PAR: A.F.	
—	—	—	—	—	DATE: FEB. 20, 2003	
—	—	—	—	—	VERIFIE PAR: —	
?	T ADAPTER, CABLE ADDED TO REMOTE O/P	A.F.	MAR.26/2003	REF. NON	TITRE: SUPERVISAIRE OPERATOR PANEL FOR DRY-O-TRON UNITS <input checked="" type="checkbox"/> 1) UNIT MOUNTED O/P ONLY <input type="checkbox"/> 2) REMOTE O/P ONLY <input type="checkbox"/> 3) UNIT MOUNTED & REMOTE O/P	
1	MAX. DISTANCE	H.X.	MAR.13/2003	ECHELLE: N.T.S.	NOL. DESSIN: FS-CW-000-010 AE DWG. NO.: REV: 2	
NO	DESCRIPTION	PARL. BY:	DATE:	CHK		

# P10 Series 9 x Unit Mounted Low Pressure Control (Single or 2-Stage)



Action on Increase of Pressure



P10BC-7 (With Bracket No. BKT16A-600R)

### Description

These pressure controls open or close electrical circuits from a change in operating air pressure. R to Y terminals make (cut-in) on pressure rise.

### Features

- visible calibrated adjustable range scale
- snap-acting switch in a dust protected enclosure
- easily accessible wiring terminals

### Accessories

- A universal mounting bracket No. BKT16A-600R as well as a barbed fitting is supplied as standard.
- Model P10FC-4 has a jumper installed on the common terminals.

### Applications

- pneumatic systems
- control of pumps or small air compressors

### Specifications

- model P10BJ-1 is rated for 24 amp non-inductive when used as an SPST (R-Y). (See *Electrical Ratings.*)
- maximum allowable pressure is 150 psig (1034 kPa).
- maximum ambient temperature is 140°F (60°C)

### To Order

Specify code number from the selection chart below.

### Selection Chart

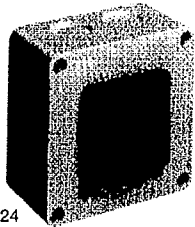
Code Number	No. of Stages	Contact Action	Range psig (kPa)	Factory Setting				Pressure Connector
				psig (kPa)		Switch Diff psi (kPa)		
<b>P10BC-7</b>	<b>1</b>	<b>SPDT</b>	<b>3 to 20 (21 to 138)</b>	<b>12 (R to Y Cut-in)</b>		<b>2</b>		<b>Barbed Fitting</b>
P10BG-3	1	SPDT	2 to 20 (15 to 138)	12 (R to Y Cut-in)		0.2		1/8 in. Female NPSF
P10BJ-1	1	SPDT	3 to 20 (21 to 138)	12 (R to Y Cut-in)		2		1/8 in. Female NPSF
P10FC-4	2	SPDT	3 to 20 (21 to 138)	(R-Y Cutout) Low Stage	(R-Y Cut-in) High Stage	Low Stage	High Stage	1/8 in. Barbed Fitting
				8 (55)	12 (82)	2 (14)	2 (14)	
P10PA-11	3	SPST	3 to 20 (21 to 138)	Stage 1 Open Low	Stages 2 & 3 Open High	Stage 1	Stages 2 & 3	1/8 in. Barbed Fitting
				6 (41)	18 (120)	3 (21)	0.4 (3)	

Electrical Ratings					
Motor Ratings VAC	120	208	240	277	600
AC Full Load Amp	16.0	9.2	8.0	7.0	--
AC Locked Rotor Amp	96.0	55.2	48.0	42.0	--
Non-Inductive Amp	16.0	9.2	8.0	7.2	--
Pilot Duty – 125 VA at 24 to 277 VAC					
AC Full Load Amp	6.0	3.4	3.0	--	--
AC Locked Rotor Amp	36.0	20.4	18.0	--	--
Non-Inductive Amp	6.0	3.4	3.0	2.6	--
Pilot Duty – 125 VA at 24 to 277 VAC					
AC Full Load Amp	16.0	9.2	8.0	7	--
AC Locked Rotor Amp	96.0	55.2	48.0	42	--
Non-Ind. Amp	Double Throw	16.0	16.0	16.0	16.0
	Single Throw	24.0	24.0	24.0	24.0
Pilot Duty – 125 VA at 24 to 600 VAC					
AC Full Load Amp	16.0	9.2	8.0	7.0	--
AC Locked Rotor Amp	96.0	55.2	48.0	42.0	--
Non-Inductive Amp	16.0	9.2	8.0	7.2	--
Pilot Duty – 125 VA at 24 to 277 VAC					
On 2- and 3-stage models, the maximum connected load shall not exceed 2000 VA					
AC Full Load Amp	6.0	3.4	3.0	--	--
AC Locked Rotor Amp	36.0	20.4	18.0	--	--
Non-Inductive Amp	6.0	3.4	3.0	--	--
Pilot Duty – 125 VA at 24 to 277 VAC					
On 2- and 3-stage models, maximum connected load shall not exceed 2000 VA					

# SGA24, SGF24 Positioners 5 x Unit Mounted



For proportional actuators with a working range of 0 to 10 VDC or 2 to 10 VDC

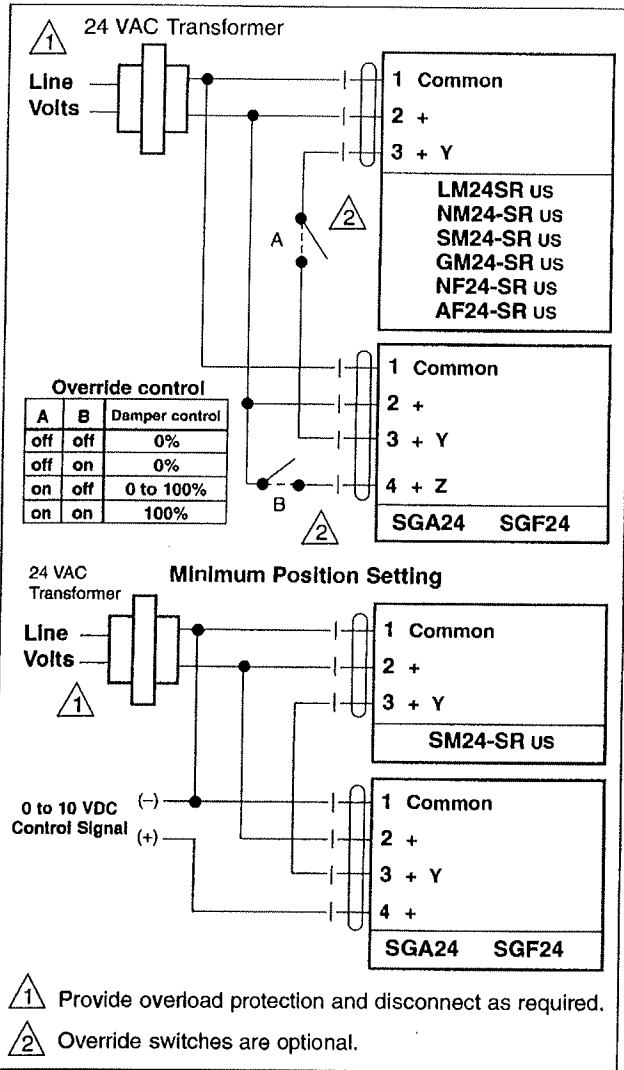


SGA24



SGF24

## Wiring diagram



Technical Data	SGA24, SGF24
Power supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Transformer sizing	1 VA
Control signal Y	.5 to 10 VDC; 2 to 10 VDC (switchable)
Power output	up to 10 actuators (1 mA max)
Degree of protection	(SGA24 only NEMA 4 [1P54])
Connection	Terminals (14 ga. wire max)
Humidity	5 to 95% RH noncondensing

## Application

These positioners are intended for the remote control of modulating actuators or for use as a minimum positioner (providing a minimum limit for the output signal from a modulating controller). The control range is 0 to 100% of the angle of rotation of the actuator.

Positioner SGA24 is for surface mounting with a NEMA 4 housing included. Positioner SGF24 is for flush mounting.

## Operation

The positioner receives its supply voltage through terminals 1 and 2. A rotary knob is turned, producing a proportional control signal (Y) at the output (terminal 3) of either .5 to 10 VDC or 2 to 10 VDC and therefore a proportional change in the position of the actuator between 0 and 100%. When used for a minimum limit, the positioner works as a higher of 2 signal selector. This function allows only the signal from the controller or positioner, whichever is greater, to go to the actuator.

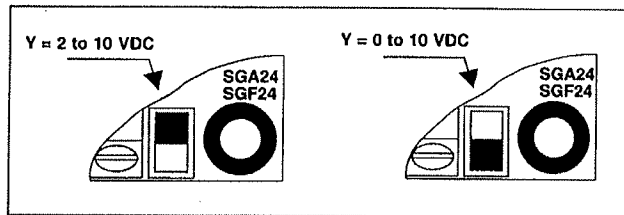
## Function

The changeover from 2 to 10 V to 0 to 10 V is selected by means of a slide switch on the printed circuit board. The angle of rotation of the knob can be limited mechanically, by moving the adjustable stops under the knob.

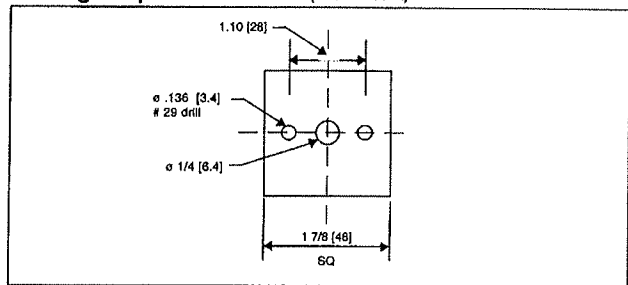
## Accessory

ZG-SGF Mounting plate for single gang wiring box

## Changeover switch

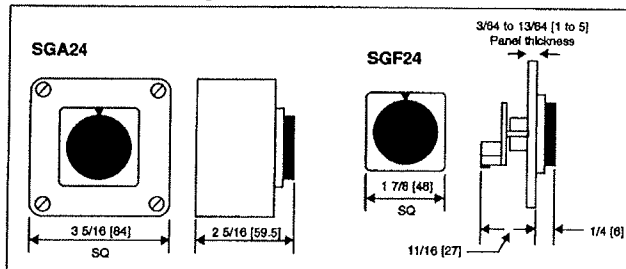


## Drilling template for SGF24 (flush mount)



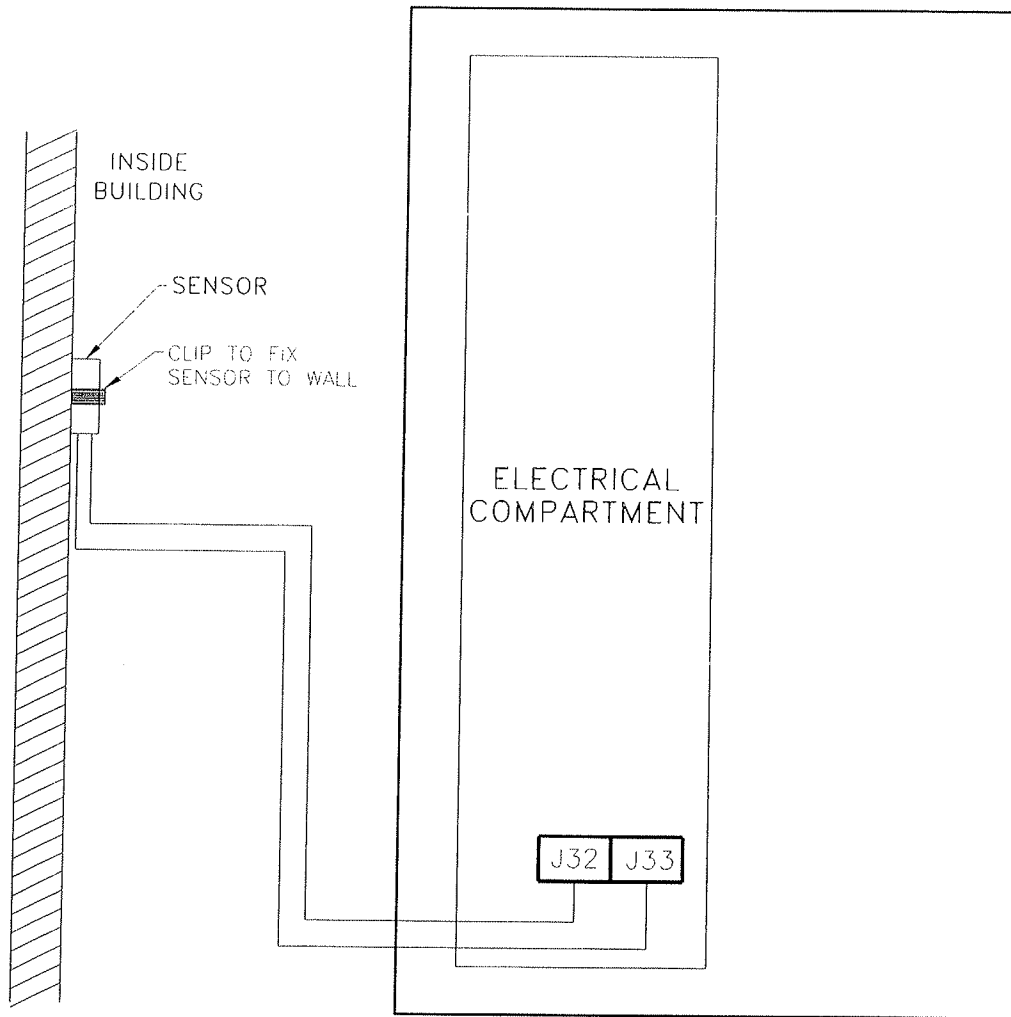
## Dimensions

All ratings in brackets are metric.




5 x Shipped Loose

DRY-O-TRON

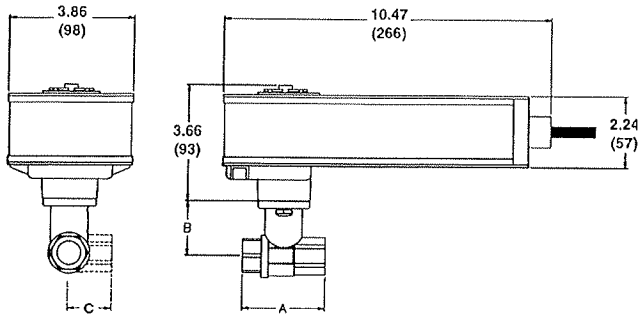


Note: Please indicate which units will be equipped with wall sensor override before release.

				DRAWN BY: J.T.	
				DATE: 98/12/02	
				CHECK BY:	
				REF. NO.:	
-	-	-	-	AUTOCAD: ST - 03	TITLE: FIELD WIRING Γ WALL TEMPERATURE SENSOR (DECTRON #: ECST0001402S)
NO.	REVISIONS	BY	DATE	CHK.	FS-W-000-330 AE
					REV.



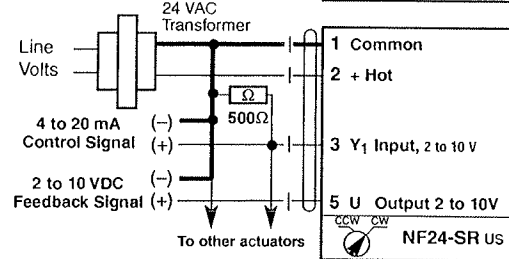
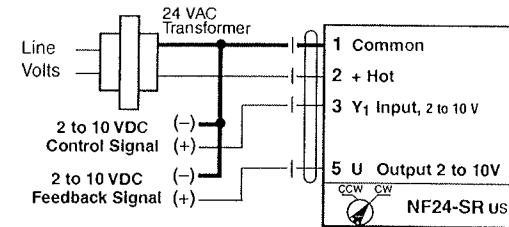
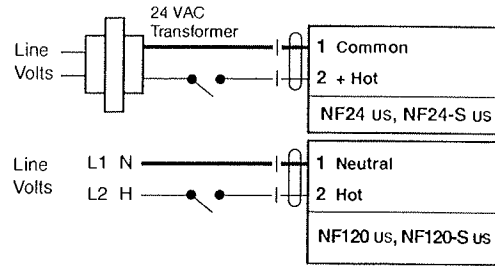
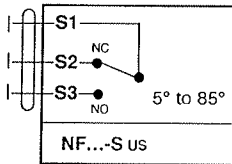
## 5 x Shipped Loose



Nominal Valve Size		Dimensions in inches (mm)		
in	mm	A	B	C <sup>†</sup>
3/4"	20	2.95 (75)	1.87 (47.5)	1.52 (38.5)
1"	25	3.43 (87)	1.87 (47.5)	1.71 (43.5)
1-1/4"	32	4.02 (102)	1.87 (47.5)	2.00 (50.8)
*1-1/4"	32	4.45 (113)	2.05 (52.0)	2.22 (56.5)
1-1/2"	40	4.45 (113)	2.05 (52.0)	2.22 (56.5)

\* On model numbers B232, B332, B231 and B331 the 1-1/4" nominal valve size has the same dimensions as a 1-1/2" valve.

† Dimension "C" applies to three-way valves only.



### On-Off Control, 24 VAC/DC Power

- NF24 us
- NF24-S us (NF24 us with built-in auxiliary switch)

### On-Off Control, 120 VAC Power

- NF120 us
- NF120-S us (NF120 us with built-in auxiliary switch)

### Proportional Control, 24 VAC/DC Power

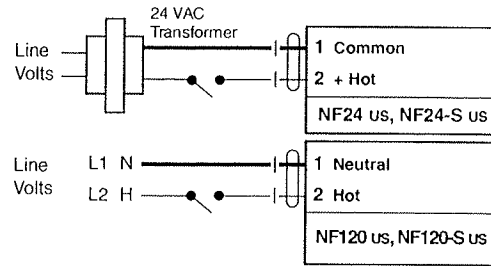
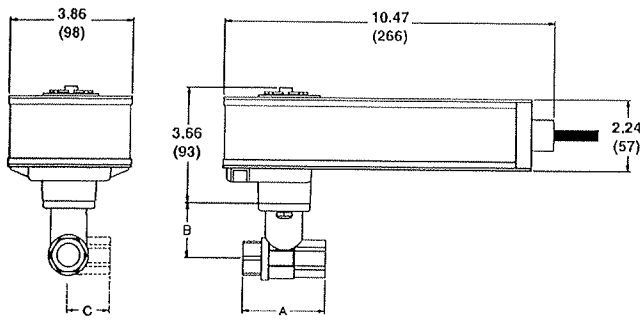
- NF24-SR us
- Control signal: 2 to 10 VDC  
4 to 20 mA (with 500Ω resistor)
- Input impedance: 100 kΩ (500Ω)
- Feedback output: 2 to 10 VDC

### Common Data

Power consumption:	3 to 6 W running, 1 to 3.5 W holding (models vary)
Transformer sizing:	6 VA (NF24-SR us), 7 VA (NF120 us) 8 VA (NF24 us), class 2 power
Electrical connection:	3 ft, 18 GA appliance cable, 1/2" conduit fitting
Electrical protection:	120V actuators/aux. switches double insulated
Overload protection:	electronic throughout rotation
Angle of rotation:	95°
Direction of rotation:	CW/CCW external switch proportional: CW=CW with decrease signal CCW=CCW with decrease signal
Spring return direction:	CW/CCW mounting
Position indication:	visual indicator
Auxiliary switch:	1 x SPDT, 5° to 85° (-S)
Running time:	<75 sec. (on-off) 150 sec. independent of load (proportional) < 60 sec. (spring)
Ambient temperature:	-22° F to 122° F [-30° C to 50° C]
Housing:	NEMA 2
Agency listings:	UL 873, CSA 4813 02, CE
Noise level:	max. 45 dB(A)

Please refer to Wiring Guide Doc. 5.2 and NF Series Doc. 2.2 for further information.

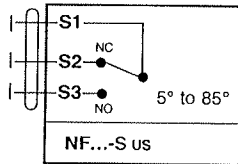
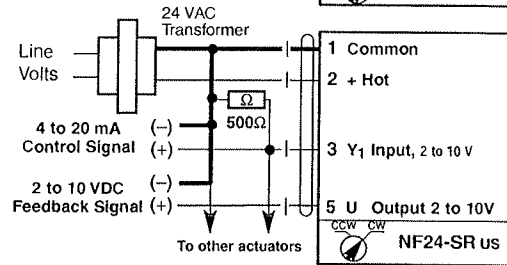
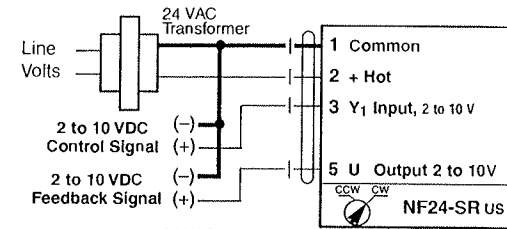
## PAU-3 CW Unit Mounted



Nominal Valve Size		Dimensions in inches (mm)		
in	mm	A	B	C <sup>†</sup>
3/4"	20	2.95 (75)	1.87 (47.5)	1.52 (38.5)
1"	25	3.43 (87)	1.87 (47.5)	1.71 (43.5)
1-1/4"	32	4.02 (102)	1.87 (47.5)	2.00 (50.8)
*1-1/4"	32	4.45 (113)	2.05 (52.0)	2.22 (56.5)
1-1/2"	40	4.45 (113)	2.05 (52.0)	2.22 (56.5)

\* On model numbers B232, B332, B231 and B331 the 1-1/4" nominal valve size has the same dimensions as a 1-1/2" valve.

† Dimension "C" applies to three-way valves only.



**On-Off Control, 24 VAC/DC Power**

- NF24 us
- NF24-S us (NF24 us with built-in auxiliary switch)

**On-Off Control, 120 VAC Power**

- NF120 us
- NF120-S us (NF120 us with built-in auxiliary switch)

**Proportional Control, 24 VAC/DC Power**

- NF24-SR us
- Control signal: 2 to 10 VDC  
4 to 20 mA (with 500Ω resistor)
- Input impedance: 100 kΩ (500Ω)
- Feedback output: 2 to 10 VDC

**Common Data**

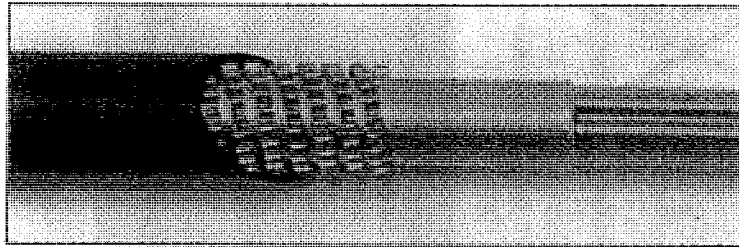
Power consumption:	3 to 6 W running, 1 to 3.5 W holding (models vary)
Transformer sizing:	6 VA (NF24-SR us), 7 VA (NF120 us) 8 VA (NF24 us), class 2 power
Electrical connection:	3 ft, 18 GA appliance cable, 1/2" conduit fitting
Electrical protection:	120V actuators/aux. switches double insulated
Overload protection:	electronic throughout rotation
Angle of rotation:	95°
Direction of rotation:	CW/CCW external switch proportional: CW=CW with decrease signal CCW=CCW with decrease signal
Spring return direction:	CW/CCW mounting
Position indication:	visual indicator
Auxiliary switch:	1 x SPDT: 5° to 85° (-S)
Running time:	<75 sec. (on-off) 150 sec. independent of load (proportional) < 60 sec. (spring)
Ambient temperature:	-22° F to 122° F [-30° C to 50° C]
Housing:	NEMA 2
Agency listings:	UL 873, CSA 4813 02, CE
Noise level:	max. 45 dB(A)

Please refer to Wiring Guide Doc. 5.2 and NF Series Doc. 2.2 for further information.

# Standard Design Features

## Double-Wall Pool Water Heater

All pool water heating DRY-O-TRON® units are equipped with a coaxial, counterflow, cupro-nickel, vented, self-draining refrigerant condenser which is suitable for potable water applications. Cross-contamination prevention is ensured.



## HyPoxy® Coated Coils

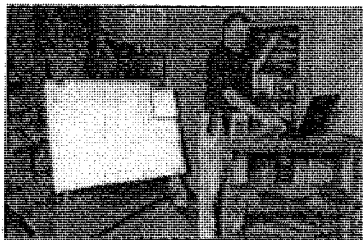
This standard coating for all air-side coils on pool applications provides superior corrosion protection while enhancing the performance of the coil due to its hydrophilic properties.

## Oversized Evaporator Coil

With 10 fins per inch, this deep and dense coil extracts the maximum amount of latent energy with the least amount of compressor power consumption, giving the DRY-O-TRON® the industry's best Moisture Removal Efficiency (MRE), expressed in lb. of moisture/kWh.

## Factory Testing

Every DRY-O-TRON® undergoes a 60-point quality control inspection under FULL load in one of the company's four test chambers, which simulates an indoor pool environment. An industry first and still the industry's best!

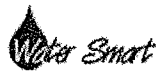


## Full-sized Condenser (Reheat) Coil

Also called a reheat coil, it is sized for the Total Heat of Rejection of the compressor for maximum flexibility in all modes of operation, including the Water Smart mode.

## Water Smart Mode

Allows the DRY-O-TRON® to continue to run in the event of a loss of pool water flow in order to satisfy space temperature and relative humidity demands.

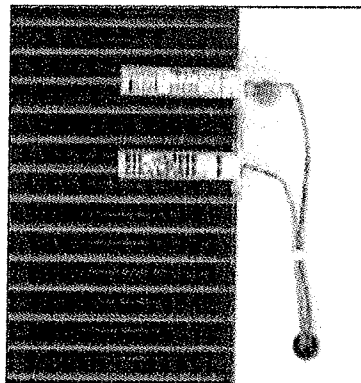


## Microprocessor Controller

On-board diagnostics and troubleshooting combined with an extensive list of points that are constantly being monitored, result in the most protected DRY-O-TRON® yet.

## Unit-Mounted Sensors

Calibrated and tested at the factory. Set points are pre-programmed for each application as per user specifications. Air side sensors have triple-dipped boards for long life.



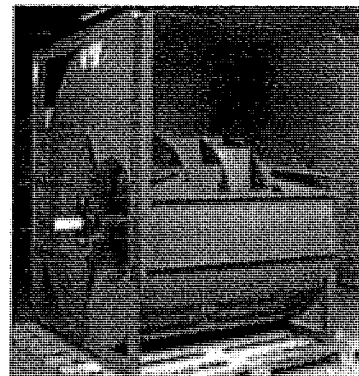
## Inverter Rated Insulation System Fan Motors

These high-efficiency fan motors have a superior insulation system for excellent spike-resistance and moisture resistance.



## BI Fan Wheels

On DRY-O-TRON® sizes 120 and up, AMCA certified Backward Inclined airfoil fan wheels are standard. Sizes 102 and smaller use Forward Curved wheels.



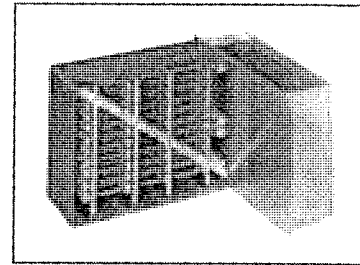
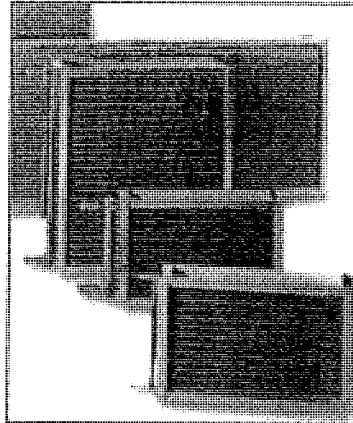
## Corrosion-proof Drain Pan

Indoor DRY-O-TRON® units have a one-piece, 12-gauge noryl resin drain pan with sanitary rounded corners. Outdoor DRY-O-TRON® units have a one-piece, 16-gauge galvanized drain pan painted with three coats of USDA-approved converted epoxy resin. The standard bottom drains are equipped with strainers.

# Optional Design Features

## Auxiliary Heat

- Hot water coil: see page 26 for standard offering (1 row/12 fpi or 2 row/8 fpi in each size)
- Steam coil: vertical tube, steam distributing type, rated at 2-35 psig available
- Electric coil: standard 2-stage or optional SCR control from 5 kW to 500 kW available
- Gas boiler: for outdoor use only. From 150 MBH to 3,500 MBH input available for auxiliary space heating and/or auxiliary pool water heating. See page 31



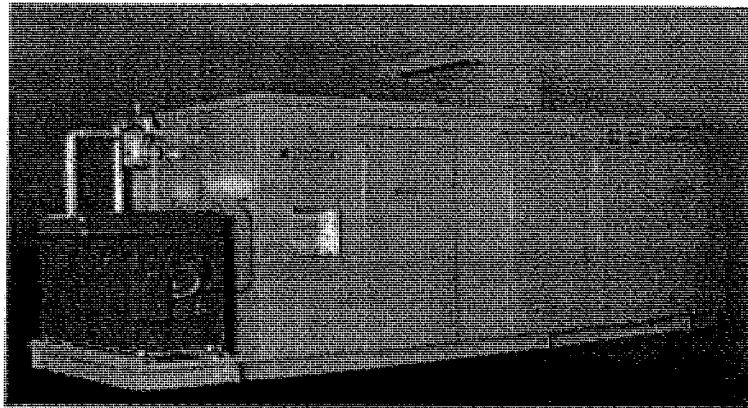
## ~~Integral Condenser~~

- ~~Packaged solution to simplify and keep installation costs down~~
- ~~Factory charged with R-22~~
- ~~Factory tested~~
- ~~Single point power connection~~



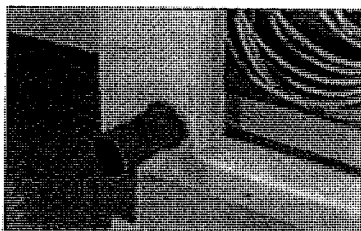
## ~~Integral Gas Boiler~~

- ~~The safest gas heat design (no chance of combustion byproducts getting into the make-up air stream) is available as a packaged solution to simplify and keep installation costs down~~
- ~~Factory charged with glycol~~
- ~~Factory tested~~



## Side Drain

When our standard bottom drain is not enough (i.e. pad-mounted DRY-O-TRON®)



## ~~Custom Paint Color~~

~~Any DRY-O-TRON® that is installed in a conspicuous location can be custom painted in the color chosen by the architect, to blend in with the décor or theme.~~

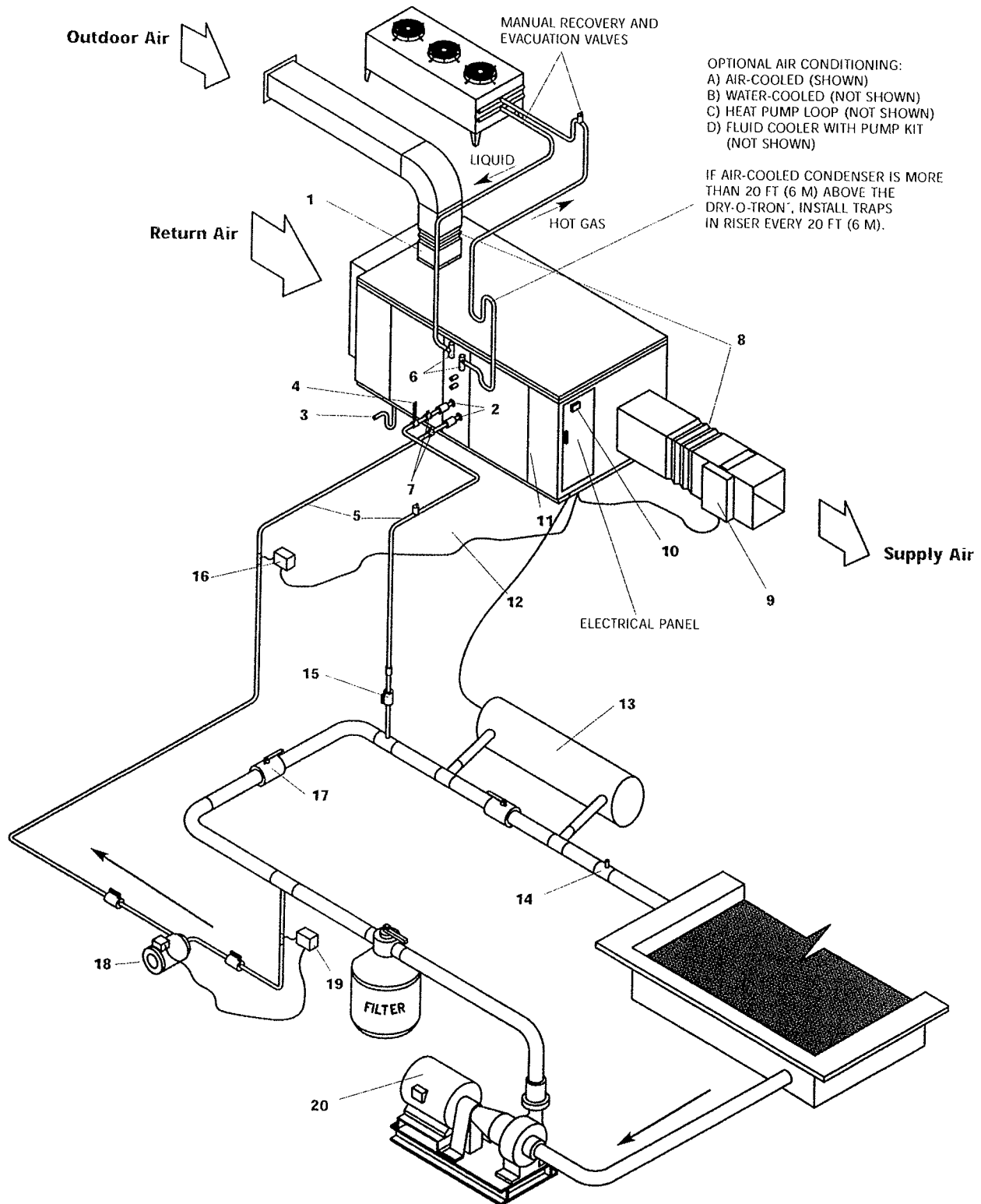
## ~~Unit-mounted Disconnects~~

~~Fused or non-fused available~~



# Installation Tips

## DRY-O-TRON® Energy Recycling Indoor Pool Environment Control



# Installation Tips

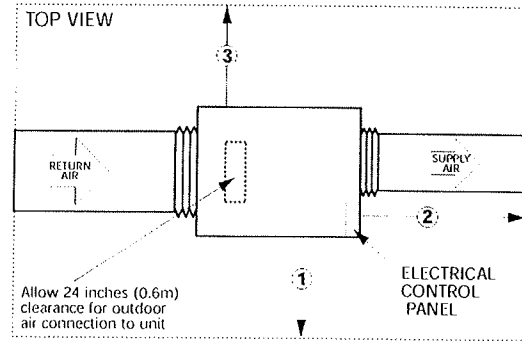
## Service Access Horizontal Units

Mechanical room temperature must be 60°F - 90°F (16°C - 32°C) to prevent excessive heat loss or gain. Only rooftop RS and RB units are designed to be located in unheated spaces. Units in attics and unconditioned spaces require extra insulation.

All Models

Service Access	1	2	3
Model 010-030	2ft (0.6 m)	3ft (0.9 m)	2ft (0.6 m)
Model 040-060	3ft (0.9 m)	3ft (0.9 m)	3ft (0.9 m)
Model 080-562	5ft (1.5 m)	3ft (0.9 m)	4ft (1.2 m)

Allow 24 inches (0.6 m) clearance for outdoor air connection to unit

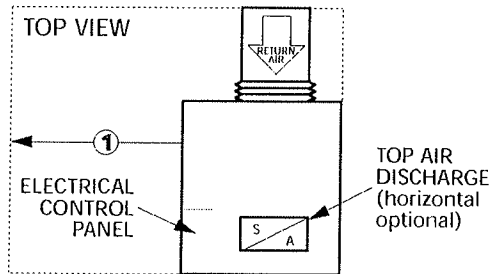


## Vertical Units

Single Side Access!

Suitable for Corner Installation

① = 3ft (0.9 m) minimum



## Weight and Filter Sizes

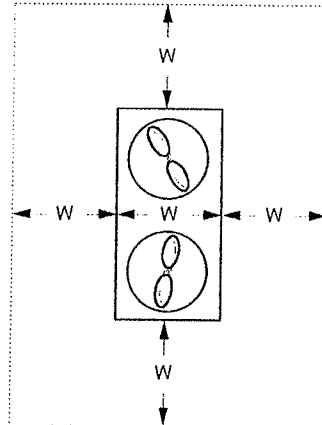
MODEL DS <sup>1)</sup>	Unit Weight (Reference only)								
	TOTAL STANDARD UNIT WEIGHT (lb)								
	HORIZONTAL AIR RETURN	RETURN AIR BLENDEM	EXHAUST FAN	PURGE	SMART SAVER & PURGE	SMART SAVER	A/C <sup>2)</sup>	HOT WATER COIL	INTEGRAL CONDENSER
010	670	-	-	-	-	-	190	-	-
015	-	-	-	-	-	-	220	-	-
020	990	-	-	-	-	-	250	-	-
030	1200	-	-	-	-	-	250	-	-
040/042	2300	2800	2900	3300	3700	3200	500	90	1400
050/060	2500	3100	3200	3700	4300	3600	770	100	1570
080	3900	4400	4600	5200	5800	5400	870	160	2000
100/102	4500	5000	5200	5800	6700	6100	1100	160	2200
120/122	5500	6100	6600	7300	8800	7000	1100	210	2500
150/152	5700	6400	6900	7500	9200	7700	1400	230	3100
162	6200	6900	7100	8200	10000	8300	1500	260	3700
182	7800	8700	9000	10300	12600	10300	2280	320	4200
202	8100	9000	9400	10800	13100	10800	2400	320	4700
242	8600	9400	9800	11100	13600	11300	2490	320	4700
282	11300	12800	13300	15000	17700	15100	2530	400	5200
362	13000	13400	13900	15500	18800	15800	2580	500	6400
482	17000	18100	19000	21700	26000	21200	2850	730	9200
562	18500	19500	20500	23200	28100	23000	3370	730	10900

1) For RS Model multiply by 1.15

2) A/C weight based on 50 ft. lines

## Outdoor Condensers and Dry Coolers

Allow the width of the condenser/dry cooler as free area around the entire perimeter of the unit.



# Terms of Limited Warranty

## Dry-O-Tron Energy Recycling Dehumidifiers (packaged units) and Factory Supplied Accessories

### General

Dectron Inc. warrants as set forth and for the time periods shown below that it will furnish to the original owner, through a Dectron Inc. authorized installing contractor or service organization, a new or rebuilt part for a part which has failed because of defect in workmanship or material. Dectron Inc. reserves the right to apply handling and inspection charges in the case of parts or equipment improperly returned as defective whether under warranty or not.

### Registration and Start-up Report

Warranty void unless upon start-up of the unit the "Start-up Report and Warranty Registration" is completed and sent to the factory within one week of initial start-up. This will also register the compressor warranty with the compressor manufacturer.

### Initial 30 Days Warranty

During the first 30 days from initial start-up and subject to prior approval from the factory Dectron Inc. will provide and/or reimburse the required labor, materials, and shipping costs incurred in the replacement of a defective part.

### Remainder of One-Year Warranty

Upon expiry of the initial 30 days warranty, and until completion of the twelfth month from date of unit start-up, or 25 months from date of shipment from Dectron Inc., whichever is earlier, if any part supplied by Dectron Inc. fails because of a defect in workmanship or material Dectron Inc. will furnish a new or rebuilt part F.O.B. factory. No reimbursement will be made for expenses incurred in making field adjustments or replacements unless specifically approved by Dectron Inc.

### Applicability

This warranty is applicable only to products that are purchased and retained in the United States and Canada. This warranty is not applicable to:

Δ Products that have become defective or damaged as a result of the use of a contaminated water circuit or operation at abnormal water temperatures and/or flow rates.

Δ Parts that wear out due to normal usage, such as air filters, belts, fuses and refrigerant.

Δ Products that have been moved from the location where they were first installed.

Δ Any portion of the system not supplied by Dectron Inc.

Δ Products on which the model and/or serial number plates have been removed or defaced.

Δ Products on which payment is in default.

Δ Products which have become defective or damaged as a result of unauthorized opening of refrigeration circuit, improper wiring, electrical supply characteristics, poor maintenance, accidents, transportation, misuse, abuse, fire, flood, alteration and/or misapplication of the product.

Δ Products operated without clean, properly installed air filters.

Dectron Inc. from the customer site and replacement part(s) from Dectron Inc. to the customer site are not covered by this warranty.

### Limitations

This warranty is given in lieu of all other warranties. Anything in the warranty notwithstanding, any implied warranties of fitness for particular purpose and merchantability shall be limited to the duration of the express warranty. Manufacturer expressly disclaims and excludes any liability for consequential or incidental damage for breach of any express or implied warranty.

Where a jurisdiction does not allow limitations or exclusions in a warranty, the foregoing limitations and exclusions shall not apply to the extent of the legislation, however, in such case the balance of the above warranty shall remain in full force and effect.

This warranty gives specific legal rights. Other rights may vary according to local legislation.

### Obtaining Warranty Service

Normally, the DECTRON INC. AUTHORIZED CONTRACTOR who installed the products will provide warranty service to the owner. Should the installing contractor be unavailable, contact your local Dectron representative or the factory.

### Force Majeure

Dectron Inc. will not be liable for delay or failure to provide warranty service due to government restrictions or restraints, war, strikes, material shortages, acts of God or other causes beyond Dectron Inc. control.



# Dectron

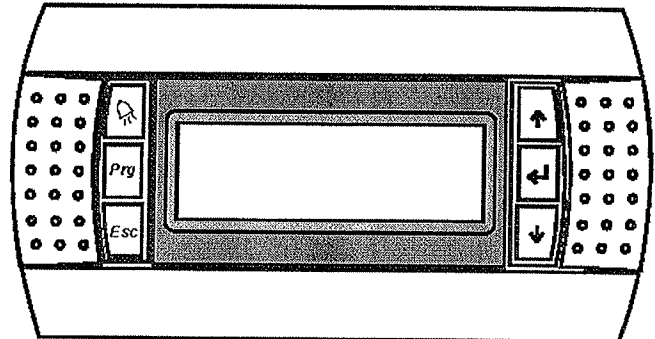
## DRY-O-TRON®

### Owner's Manual

FOR MODELS

DS	DSV	DB	RS	RB
010	010		010	
015	015		015	
020	020		020	
030	030		030	
040	040	040	040	040
042	042	042	042	042
050	050	050	050	050
060	060	060	060	060
062	062	062	062	062
080	080	080	080	080
082	082	082	082	082
100	100	100	100	100
102	102	102	102	102
120	120	120	120	120
122	122	122	122	122
150	150	150	150	150
152	152	152	152	152
162		162	162	162
182		182	182	182
202		202	202	202
242		242	242	242
282		282	282	282
362		362	362	362
482		482	482	482
562		562	562	562

With *Supervisaire*® CONTROLLERS  
with PGD REMOTE TERMINALS



For future reference, write your model number\* here \_\_\_\_\_  
 write your serial number\* here \_\_\_\_\_  
 write your ref number\* here \_\_\_\_\_

\*See Product Description - Unit Nameplate.



Contents

**DRY-O-TRON® DS Series  
Energy-Recycling  
Dehumidifiers and  
Water Heaters for  
Indoor Pools,  
Whirlpools and Spas**

DRY-O-TRON® is the original energy recycling dehumidifier. Tens of thousands of units have been installed throughout the world, and DRY-O-TRON® has become synonymous with quality, reliability and energy savings.

Dectron Inc., the inventor of DRY-O-TRON®, is a company committed to being the absolute best at what they do - providing leading expertise and quality products to customers who need to control high humidity efficiently.

Today's DRY-O-TRON® represents years of intensive research and development by a team of highly qualified experts. Dectron has the only large-scale dehumidifier testing and environmental simulation laboratory in the industry. Every DRY-O-TRON® model line has been developed in this laboratory, and every customer's unit is fully factory tested before shipment.

The DRY-O-TRON® is available in a broad range of standard products for industrial and commercial applications. We also have a team of highly skilled engineering and manufacturing professionals who are dedicated to custom design projects.

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Product Description

Features

▲ The basic Dectron DS series DRY-O-TRON® units offer dehumidification of natatorium air as well as pool water heating. The optional Cooling mode offers space cooling.

▲ The DS series DRY-O-TRON® unit controls an auxiliary pool water heater as necessary to maintain pool water temperature.

▲ An optional hot-water heating system is available to make use of a building boiler system for heating. This factory modification must be ordered at time of purchase.

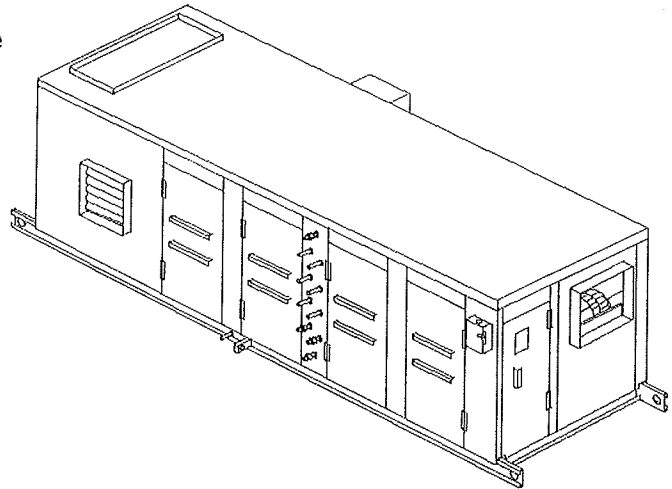
▲ DS series DRY-O-TRON® units are supplied with heat exchangers, air filter(s), and all controls.

▲ An optional outdoor air intake system includes an automatic damper to stop the outdoor air flow during unoccupied periods.

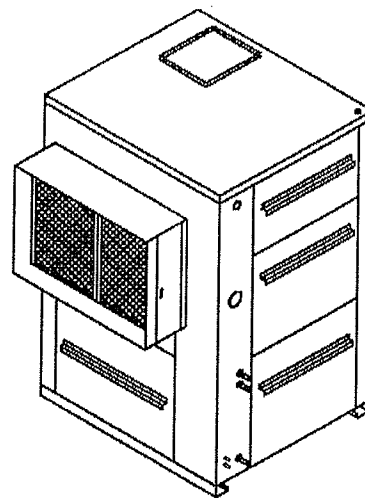
▲ A microprocessor control system automatically determines the proper operating mode, based on conditions and occupation. A simple connection to building management systems is available.

▲ Energy consumption

The DS DRY-O-TRON® series offers a temperature and humidity monitoring system that insures the unit is working only as necessary. Automatic refrigeration staging in the remote chiller matches the system capacity to the load. Energy consumption is always minimized.



Horizontal Configuration



Vertical Configuration

DESCRIPTION

Major Airflow Options

Product Description

DESCRIPTION

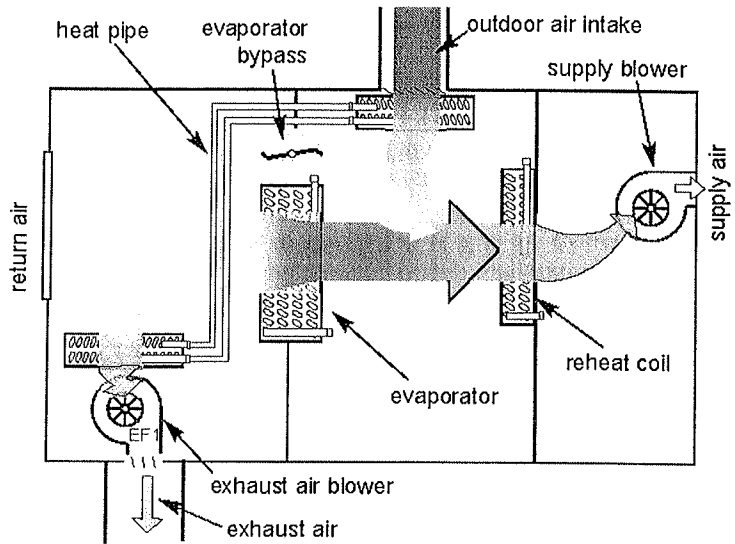
**DRY-O-TRON® with SmartSaver®**

The SmartSaver® exchanges heat from the exhaust air to the incoming outdoor air to save heating energy.

The same amount of air passes through the bypass and the evaporator.

Under normal conditions, up to 30% of the total supply air can be pre-heated outdoor air. The exhaust air flow rate should be 110% of the outdoor air intake flow rate.

A heat pipe or a thermo-siphon system is installed between the exhaust air and the outdoor air intake. When the outdoor air is colder than the room exhaust air, the SmartSaver® recovers heat from the exhaust stream and delivers it to the outdoor air intake.



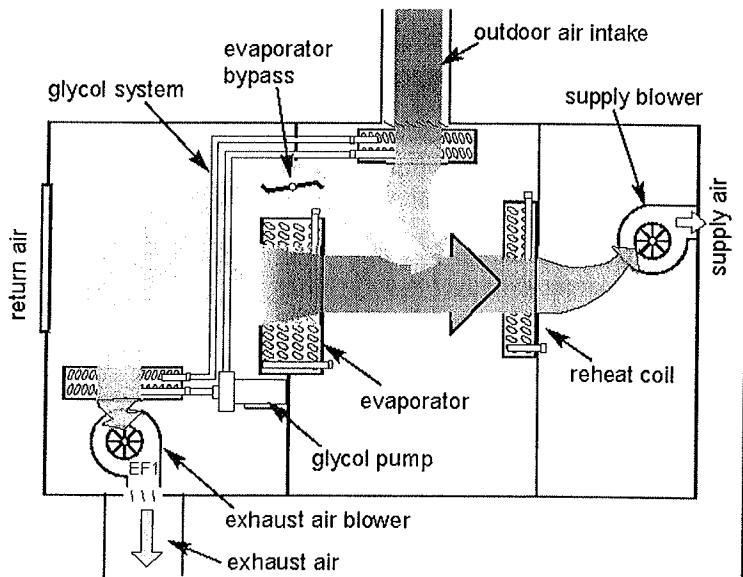
**DRY-O-TRON glycol SmartSaver®**

The SmartSaver® exchanges heat from the exhaust air to the incoming outdoor air to save heating energy.

The same amount of air passes through the bypass and the evaporator.

Under normal conditions, up to 30% of the total supply air can be pre-heated outdoor air. The exhaust air flow rate should be 110% of the outdoor air intake flow rate.

A pumped-glycol heat-exchange system is installed between the exhaust air and the outdoor air intake. When the outdoor air is colder than the room exhaust air, the SmartSaver® recovers heat from the exhaust stream and delivers it to the outdoor air intake stream. When the outdoor air is warmer than the room exhaust air, the SmartSaver® removes heat from the outdoor air intake stream and delivers it to the exhaust air stream.



Major Airflow Options

Product Description

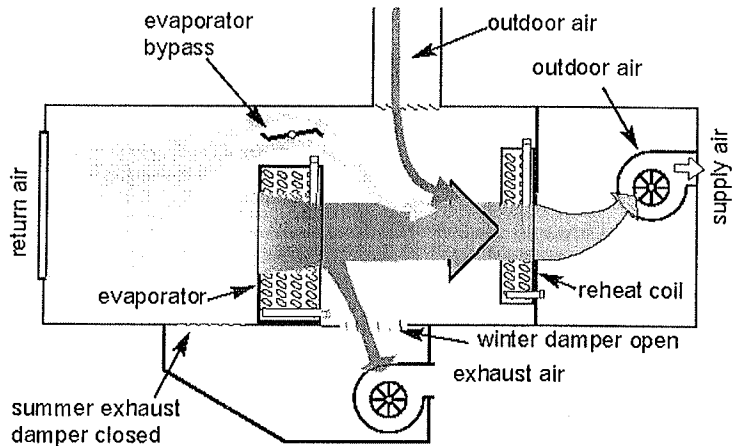
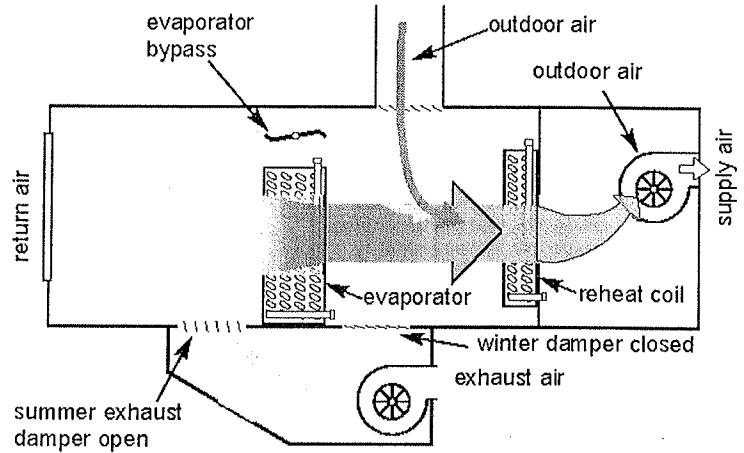
**DRY-O-TRON® with EconoSaver®**

The EconoSaver® reduces the amount of energy needed for heating by recovering heat with the refrigeration system.

The same amount of return air passes through the evaporator and the evaporator bypass.

The outdoor air intake flow rate can be up to 15% (or up to 35% with the air-conditioning option) of the total supply air flow rate.

In the summer room air is exhausted directly. In winter mode, cold air from the evaporator is exhausted. The heat removed from the exhaust air is returned to the incoming outdoor air in the reheat heat exchanger. This reduces the energy needed for heating.



DESCRIPTION

Moisture Migration

Natatorium

The pool enclosure must be built to the latest building codes and must be suitable for year round operation at 50% to 60% relative humidity.

Δ Vapor Retarder

Before the design of the roof and walls is finalized, the enclosure temperature and relative humidity must be known; thus determining the dew point (the temperature at which condensation will occur). Any building surface below this dew point temperature will condense water from the air.

**IMPORTANT!**

**Check the pool enclosure design (exterior walls AND ceilings) for proper vapor retarder location.**

When the outdoor air temperature is sufficiently low, parts of the exterior wall and ceiling will be at or below the dew point temperature. These parts **MUST** be on the outdoor (or cold side) of the vapor retarder.

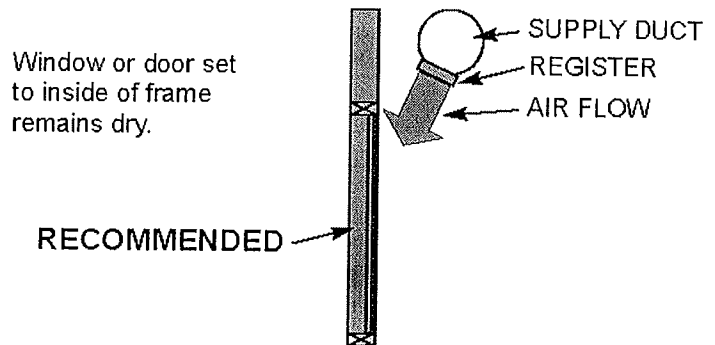
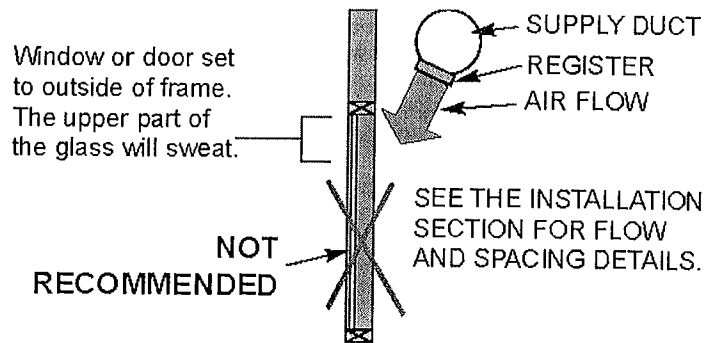
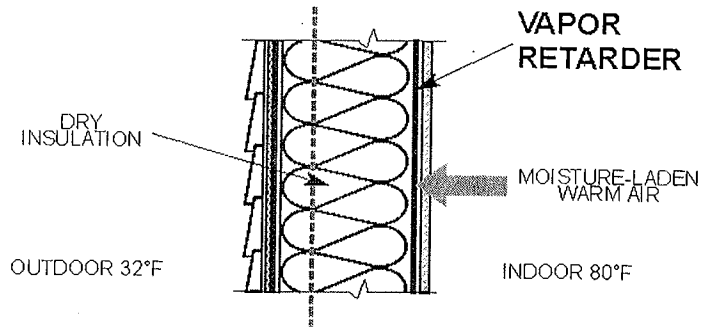
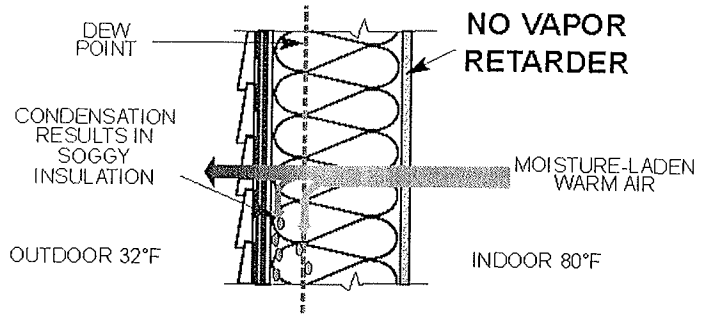
Failure to install the vapor retarder properly will result in condensation forming in the structure with all the consequent damages.

Δ Window Design

Special attention must be paid to the exterior glass components such as windows and patio doors. Due to their low insulation values, windows are usually the building element with the lowest inside surface temperature. Even a triple pane window can have an inside surface temperature below the room dew point.

The entire surface area of exterior windows **MUST** be blanketed with warm supply air from the perimeter air distribution system to raise the window's inside surface temperature above the dew point to prevent condensation. Windows must be designed to allow unobstructed air movement on the inside surface. Avoid windows with panes recessed to the outside. Avoid heavy window frames which protrude to the inside. Both of these prevent proper air movement and result in condensation.

Other building elements which create thermal bridges must either be avoided or be blanketed with warm air to prevent condensation damage. Skylights are especially vulnerable to condensation, as a direct air supply is very difficult to achieve.



NATATORIUM

Unpacking and locating

Installation

**Important!**

Inspect your unit immediately for shipping damage. Claims for shipping damage must be made with the shipping company. Dectron is not responsible for shipping damage.

Your unit has been factory tested for proper operation. Inspect the unit carefully upon arrival.

Notify the carrier immediately if shipping damage is suspected. If internal damage is suspected, indicate "contingent on internal inspection" when signing for the shipment. Keep copies of all documents, including photographs of any damage.

**Δ Storage**

It is best not to store your DRY-O-TRON® for long periods. If it must be stored, both indoor and outdoor units should be stored indoors in a space that is safe from accidental damage or vandalism. Where more than one DRY-O-TRON® are stored together, maintain proper inventory identification since each DRY-O-TRON® is designed to a particular job specification.

**Δ Unpacking**

On a level surface, remove external crating materials. Remove any fasteners securing the unit to the freight skid.

**Important!**

Locate your unit where it will be protected from damage. Allow adequate space for service.

Care must be taken to separate any fresh air intake from sources of contamination, such as drain vents and burner flues.

**Δ Select a suitable location** for the unit, where the unit will not be subject to damage, and where the remote-condenser tubes (if any) will be no longer than specified on the unit nameplate.

Allow at least three feet (1 meter) of service access space on all four sides of the unit. Spacing requirements are also subject to applicable electrical codes. For units with hooded air intakes allow at least 3 feet (1 meter) of clear space around the hood for smooth intake air flow.

Intake air hoods should be suitably separated from such sources of contamination as drain vents and burner flues. See appropriate codes and standards.

See **Installation - Isolators and Drain** before proceeding.

**Δ Lifting**

Lift using only the integral lifting lugs. Where lifting lugs are not supplied, lift with forklift at the indicated points only.

Refer to the corner weights provided by Dectron. Do not use clamps or slings. Use spreaders to prevent squeezing the DS cabinet.

**Δ Mechanical Room**

Adequate space **MUST** be planned in advance for the mechanical room and duct work. If inadequate space is provided, then ductwork cannot be properly installed and the system will not function satisfactorily. Service access to the equipment is also very important for everything from air-filter replacement to maintenance and service checks.

**Δ Chemical Storage**

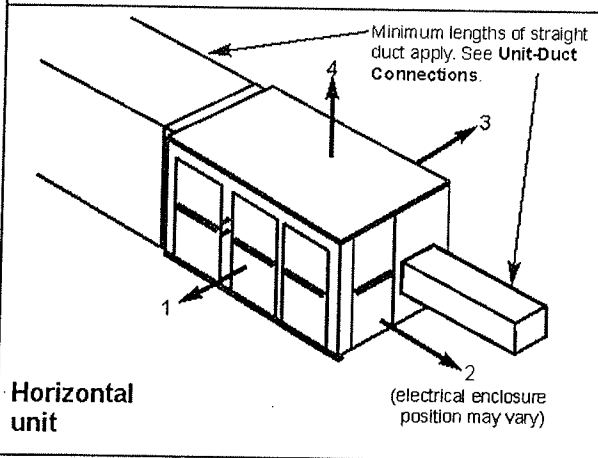
A separate, ventilated space at negative pressure **MUST** be provided for pool chemicals. **Do not store chemicals in the mechanical room, or in any space that is ventilated into the conditioned space! Check your local codes.**

**Δ Completing**

After the unit is positioned remove any internal shipping braces or pads. Release or remove any blower restraints. Confirm blower belt tension. Release or remove any compressor locks or restraints.

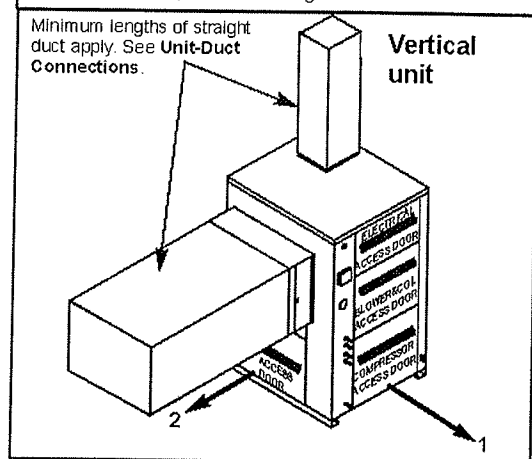
Minimum Service Access <sup>a</sup> ft (m)	1	2	3	4
DS-010 - DS-030	2 (0.6)	3 <sup>b</sup> (1)	2 (0.6)	3 (1)
DS-040 - DS-060	3 (1)	3 <sup>b</sup> (1)	3 (1)	3 (1)
DS-080	5 (1.5)	3 <sup>b</sup> (1)	4 (1.2)	3 (1)

**a** - access doors must be able to open to at least 90°.  
**b** - (Canada) 1 meter  
 (USA) 3 ft for 230V, 3.5 ft for 460V units or per NEC exhibit 110-7, whichever is greater.



Minimum Service Access <sup>a</sup> ft (m)	1	2
DV5-010 - DV5-080	3 <sup>b</sup> (1)	2 (.6)

**a** - access doors must be able to open to at least 90°.  
**b** - (Canada) 1 meter  
 (USA) 3 ft for 230V, 3.5 ft for 460V units or per NEC exhibit 110-7, whichever is greater.



INSTALLATION

Locate Remote Condenser

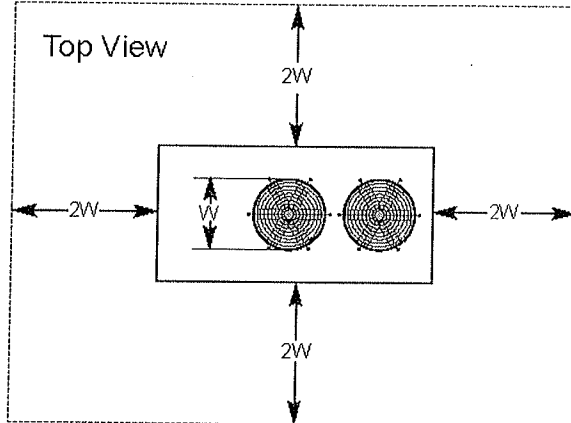
Installation

For units with air-cooled air conditioning, select a suitable location for the remote condenser, where it will not be subject to damage. Allow at least twice the width of the condenser fan of clear space around the condenser for smooth intake air flow and service accessibility. Spacing requirements are also subject to applicable electrical codes. Allow at least 10 feet (3 meters) of open space above the unit for exhaust air flow.

NOTE: The length of the tubes connecting the remote air-cooled condenser to the DRY-O-TRON® must not exceed the length shown on the DRY-O-TRON® nameplate (See Product Description - Unit Nameplate.)

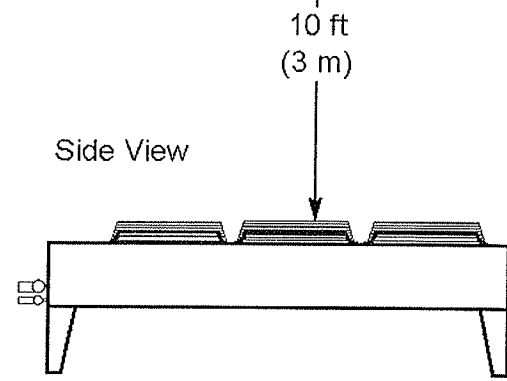


Allow clear space around the condenser equal to at least twice the width of the condenser fan.

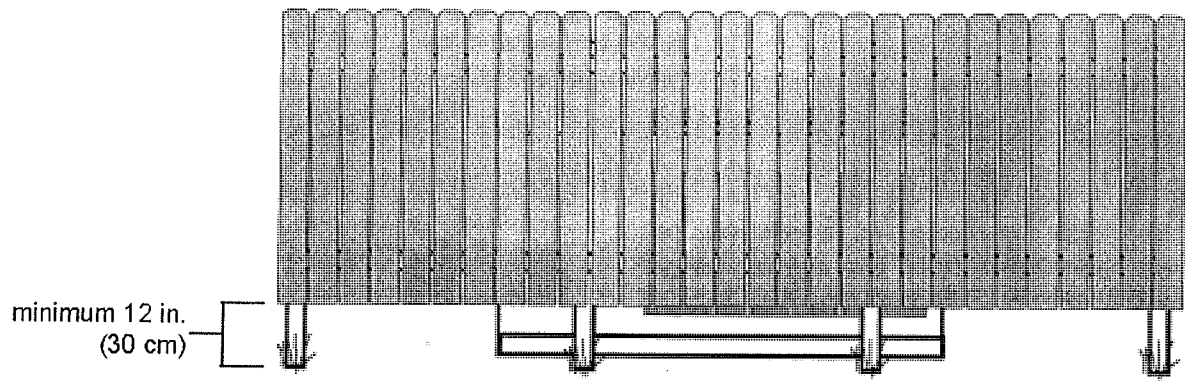


any overhanging obstruction

Allow clear space above the condenser.



The condenser should **not** be enclosed within a solid fence or wall, since such structures promote recirculation of air. If a fence or wall must be installed, it must be no closer to the condenser than "2W" (twice the width of the condenser fan) shown above, and must not extend lower than 12 inches (30 cm) above grade. Fences lower than 12 inches above grade may cause recirculation of heated air and a corresponding reduction in performance. Grass and/or other vegetation must be kept trimmed.



INSTALLATION

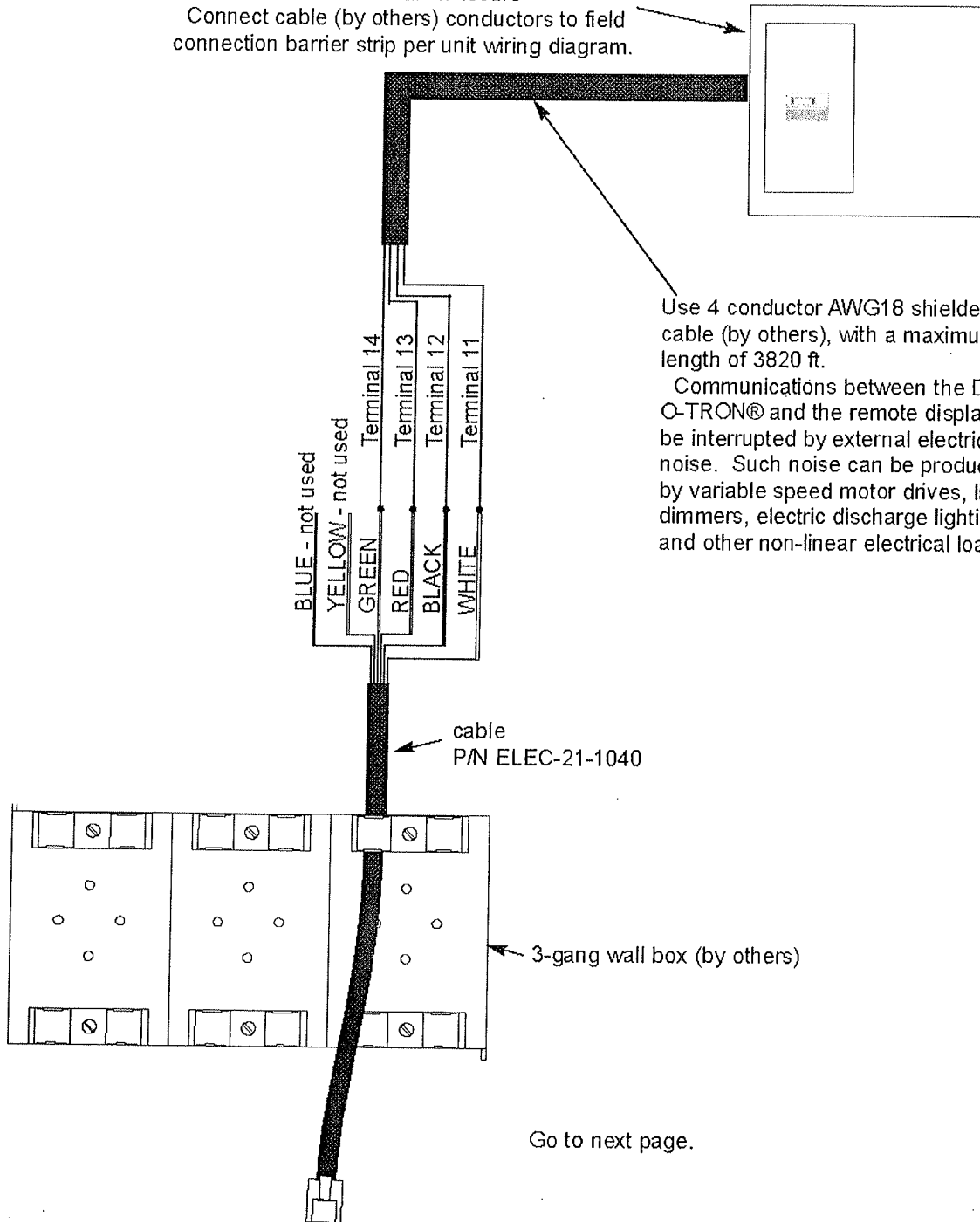
Control Signals

Wiring

Installation

Some installations may use an optional remote display. Run the extension cable to the optional display as shown here. Be sure to turn the electrical power OFF until the wiring is complete.

DRY-O-TRON® electrical enclosure  
Connect cable (by others) conductors to field connection barrier strip per unit wiring diagram.



Use 4 conductor AWG18 shielded cable (by others), with a maximum length of 3820 ft.

Communications between the DRY-O-TRON® and the remote display can be interrupted by external electrical noise. Such noise can be produced by variable speed motor drives, light dimmers, electric discharge lighting, and other non-linear electrical loads.

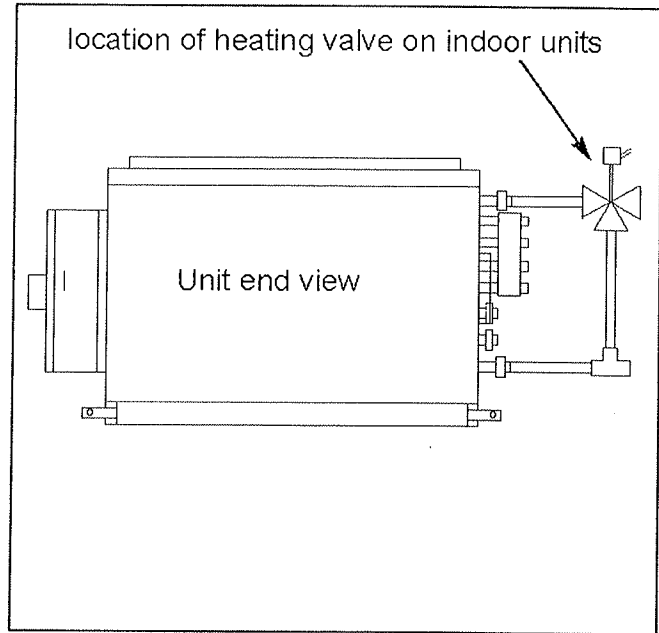
Go to next page.

INSTALLATION



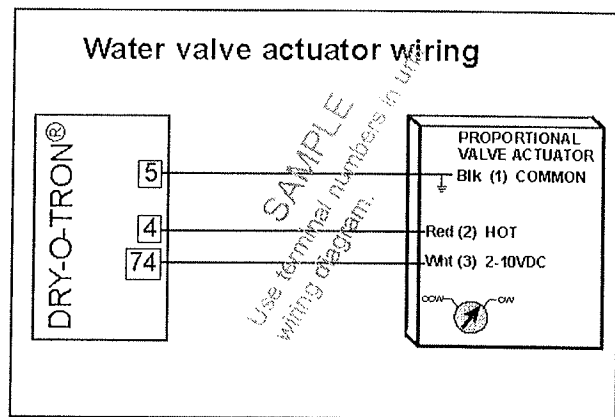
### HOT WATER OR STEAM HEAT UNITS ONLY

Some installations may have hot water or steam heating systems. In these cases there may be an electrically actuated valve to control the flow of the hot fluid. On D series (indoor) units, this valve is located outside the unit cabinet.



In this case the valve is installed in the field. The actuator must be wired exactly as shown. Failure to follow these instructions exactly may cause permanent damage.

**Actuator wiring must follow the wiring diagram for your unit. Take care to prevent the application of other voltages to these wires.**



**OPTIONAL REMOTE OUTDOOR AIR TEMPERATURE SENSOR**

Some installations may have the (optional) remote outdoor air temperature sensor. For these installations, the sensor may ship uninstalled, and thus have to be installed in the field.

Select a location for the sensor that will be out of direct sunlight or other abnormal temperature conditions.

Wire the sensor as shown on the unit field-wiring diagram in the unit information package. Route the wire to avoid sources of electrical noise.

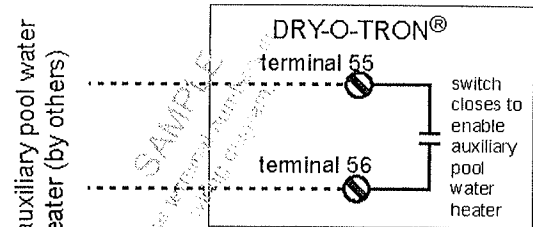
If an outdoor temperature sensor is used, the controller must be told that it is connected, see **Startup - Outdoor Temperature Sensor**.

**OPTIONAL AUXILIARY POOL WATER HEATER**

Some DRY-O-TRON® units may come equipped with an auxiliary pool water heater. In this case the wiring and controls are arranged at the factory.

Some installations may use an auxiliary pool water heater by others. In this case the auxiliary pool water heater controls must be wired to the DRY-O-TRON® controls (see unit wiring diagram in unit information package). The installer must arrange the connections so that a dry contact switch closure in the DRY-O-TRON® will enable the auxiliary pool water heater (by others). For changes to the use of an auxiliary pool water heater (by others) consult Dectron or a Dectron certified technician.

The DRY-O-TRON® dry contacts are rated 5A at 24VAC 60Hz. Do not attempt to use an internal DRY-O-TRON® power source unless so directed by Dectron.

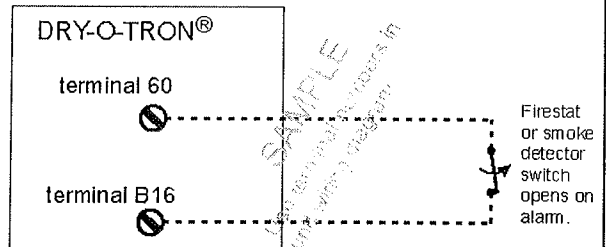


A similar circuit is used for a second auxiliary pool water heater. See the unit field wiring diagram in the unit information package.

**FIRESTAT CONNECTION**

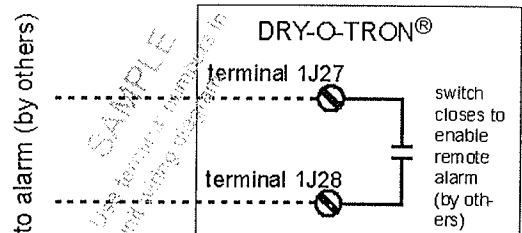
For units requiring a firestat interlock, remove the jumper between terminals 60 and B16, or as shown on the unit wiring diagram. In the jumper's place substitute an isolated normally closed switch closure from the fire alarm (by others).

If the fire alarm is triggered, the resulting open circuit between these terminals will cause the DRY-O-TRON® to execute an orderly shutdown, including blowers.



**GENERAL ALARM**

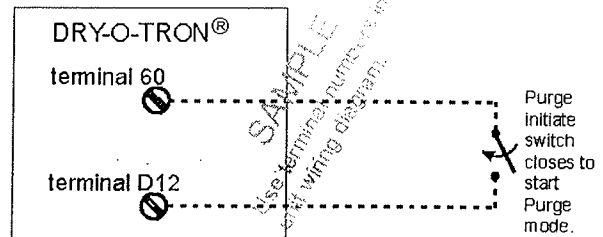
All DRY-O-TRON® units are provided with an output for a general alarm. A dry contact switch closure is provided to trigger an alarm (by others) in the event of a condition that prevents the normal operation of the unit. The DRY-O-TRON® dry contacts are rated 5A at 24VAC 60Hz. Do not attempt to use an internal DRY-O-TRON® power source unless so directed by Dectron.



**PURGE INITIATION SWITCH**

Some DRY-O-TRON® units may be provided with the optional Purge mode (see **Product Description**). In this case the installer may connect a normally open momentary push button switch at a convenient location. Purge mode begins when the switch is pressed.

Alternatively, Purge mode may be initiated from the interface. See **Operation - Interface Map**.



INSTALLATION

Unit - Duct Connections

Installation

**Important!**

Poor duct design can reduce the amount of air delivered.

Duct design must conform to the ASHRAE low-pressure, low-velocity duct standards. If there is a question concerning duct design, sizing, choice of materials, air velocities, or static pressures contact Dectron for assistance.

Air velocities should be kept low to allow good air movement and low noise. Higher static pressures result in higher power requirements and increased noise. The maximum external static pressure is

specified for each unit. Static pressures higher than specified may reduce air flow below the minimum acceptable value.

Select grilles, registers, and diffusers for low static pressure loss, required throw, and specified air flow. Choose hardware resistant to deterioration due to chemicals in the pool enclosure.

**Δ Duct material**

The DRY-O-TRON® is suitable for use with any duct material, subject to the requirements of this section and standard practice. Standard galvanized steel duct is recommended.

All elbows must be equipped with

aerofoil turning vanes and acoustic insulation.

Where located in areas below room temperature, ductwork must be insulated on the outside with 2 inch fiberglass wrap with FSK facing. All ducts must be designed to be dry. All seams must be sealed.

**Δ Flexible duct connectors**

Use flexible duct connectors to attach the ducts to the DRY-O-TRON®. Install the flexible duct in such a way as to prevent mechanical loads from being applied to the unit, and to prevent unit vibration from being transmitted to the ductwork.

**Return Duct**

Poor return-duct design can prevent proper dehumidification by causing uneven air distribution over the evaporator. Reduced capacity and/or equipment damage may result.

It is very important to allow straight length in the return duct as shown. There should be no elbows, transitions, offsets, or other flow interruptions closer than 2.5 X WIDTH of the return duct opening.

If turning vanes are not used in elbows, allow a length of straight duct equal to at least 5 X WIDTH.

The straight length is not required for units with top or bottom return air connections.

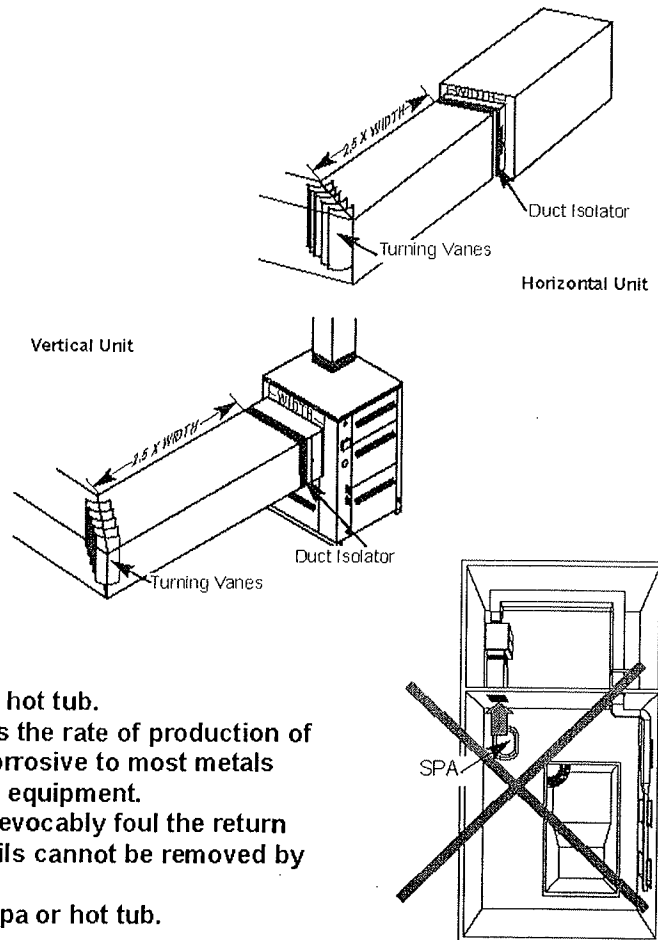
Never install a DRY-O-TRON® natatorium dehumidifier in a return-air plenum room. Corrosive chemicals in the air will shorten the life of the electrical components.

Never install the return duct grille near a spa or hot tub.

The temperature and agitation of spas increases the rate of production of corrosive chloramine gases. Chloramines are corrosive to most metals found in buildings, electrical systems, and HVAC equipment.

Also, over time oxidized human skin oils will irrevocably foul the return duct and damage the DRY-O-TRON®. Oxidized oils cannot be removed by washing.

A better solution is to exhaust the air over the spa or hot tub.



INSTALLATION

Unit - Duct Connections

Installation

Ventilation, Method 1

Some DRY-O-TRON® units may be factory equipped for the direct intake of makeup air. The makeup air flow rate with this method is limited to no more than 15% (30% with air conditioning option) of the total air flow rate.

**Note:** In cold climates, outdoor air should be heated (by others) to room temperature before entering a DRY-O-TRON® that does not have the air-conditioning option.

Outdoor air must be filtered before entering the DRY-O-TRON®.

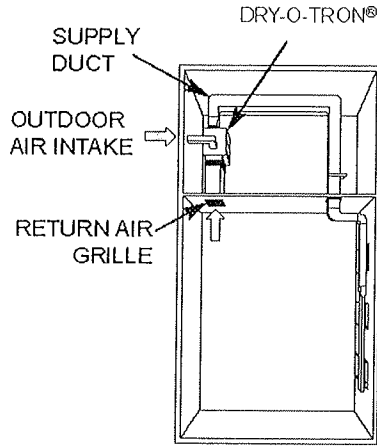
Be sure to connect the makeup air to the identified port only. **Never connect an outdoor air intake to the return duct.**

When makeup air is brought into a space, it is also necessary to exhaust 110% of the amount being brought in. This maintains a slight negative pressure on the space and reduces moisture movement into the rest of the building.

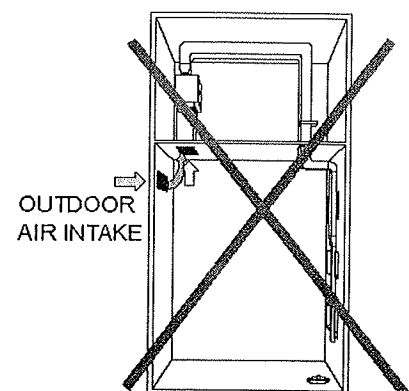
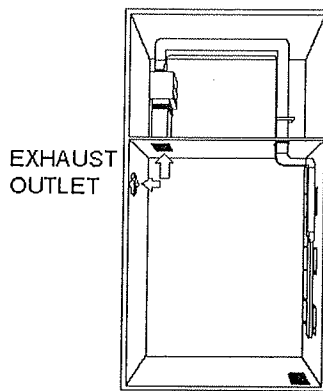
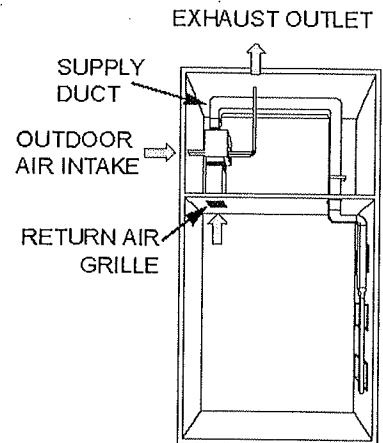
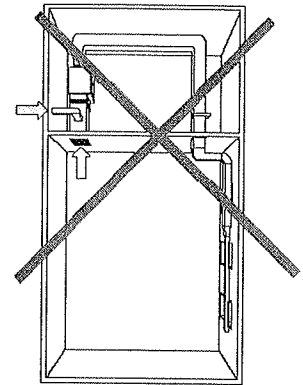
Some DRY-O-TRON® units may be equipped with both makeup air intake and exhaust air outlets. In this case connect the outdoor air and exhaust air ducts to the identified ports only. **Never connect an outdoor air intake to the return duct.** Locate the exhaust far from the intake.

Some facilities may already have separate ventilation systems. In this case, the DRY-O-TRON® can control ventilation as needed.

Arrange makeup air to enter the room far away from the DRY-O-TRON® return duct grille. **Never allow outdoor air to enter the return grille.**



**NEVER BRING OUTDOOR AIR INTO THE RETURN DUCT.**



↑ OUTDOOR AIR INTAKE

EXHAUST ↓ OUTLET

Unit - Duct Connections

Installation

Supply Duct

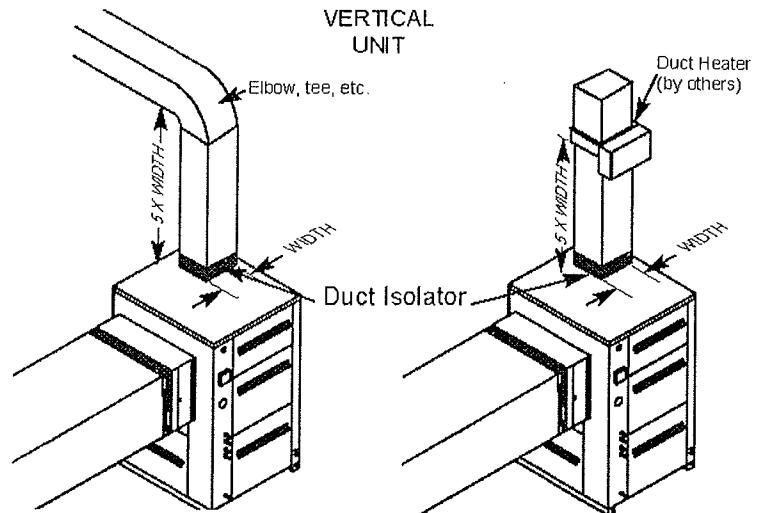
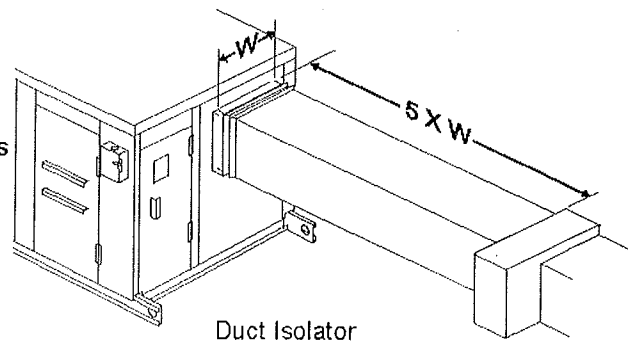
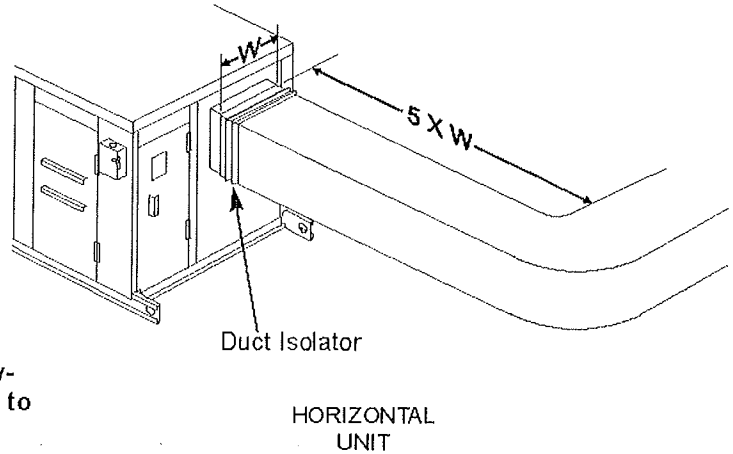
Refer to AMCA<sup>1</sup> guidelines for system effect considerations.

To prevent unexpected external energy loss, allow a section of straight duct with a length five times the blower width leaving the DRY-O-TRON®. There should be no elbows, transitions, offsets, duct heaters, or other flow interruptions closer than 5 X the width of the blower.

On special order, Dectron may be able to provide bottom, top, or side discharge blowers. On special order, Dectron may be able to offer reversed blower rotation.

Some units may have external duct heaters (by others). To prevent heater failures and hot spots, locate the heater at least 5 X the duct width away from the blower, or any air flow interruptions such as elbows and transitions.

Some units may have dampers to close off one or more ducts. Use care to assemble ducts so that these dampers will not be obstructed.



1. Air Movement and Control Association International, Inc.  
30 West University Drive  
Arlington Heights, Illinois 60004-1893

INSTALLATION

**Air Distribution**

**Installation**

**Do not blow supply air directly across the pool surface or wet deck.**

**Δ Reduce evaporation**

The air velocity directly above and close to the pool water surface should be in the 10 to 30 feet per minute range. Higher air velocities can increase the evaporation rate of the pool, greatly reducing humidity control efficiency and increasing energy consumption.

**Δ Improve bather comfort**

Due to wind chill, bather comfort is also increased by keeping air velocity near the pool as low as possible, especially for swimmers just leaving the pool water.

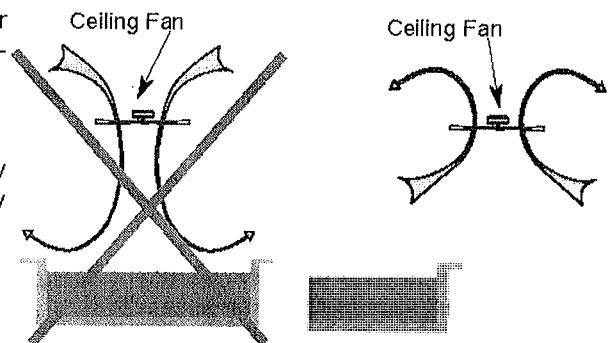
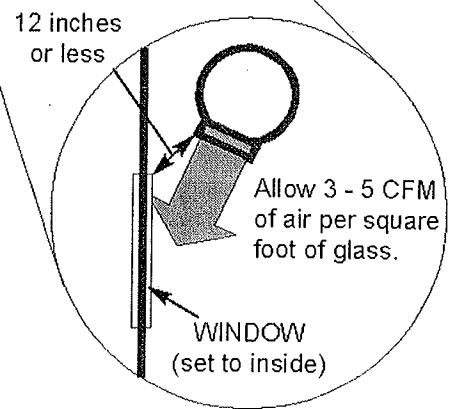
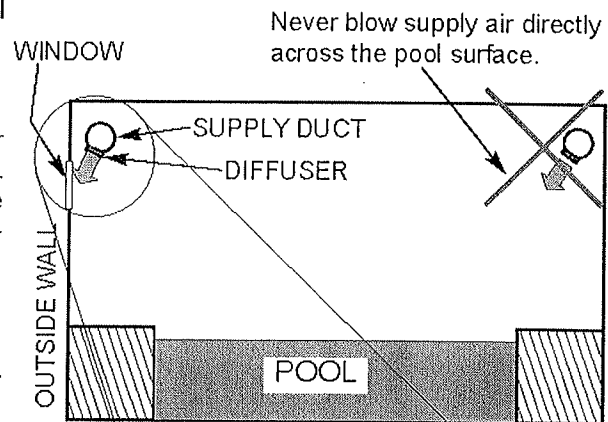
**Δ Prevent Condensation**

The quantity of supply air and the air velocity from the air distribution system must be sufficient to blanket the areas with low R-values, especially exterior glass components, with warm, dry air.

The design goal is to keep all surfaces at least 5°F above the natatorium dew point temperature. (See table below.) Supply air must be blown directly onto the entire surface of the glass using linear diffusers in order to prevent condensation.

For windows mounted high on walls, supply air must be directed at the glass surface from close range (register throws less than twelve inches to the closest portion of the glass). Air quantity and velocity must be large enough to blanket the entire glass surface with warm dry supply air. Pool rooms with a number of high windows on the wall and/or skylights should have a perimeter type air distribution located high up as well.

**Δ** If a ceiling fan is used, locate it over the pool deck only and use up-flow operation. Other operation may greatly increase pool evaporation.



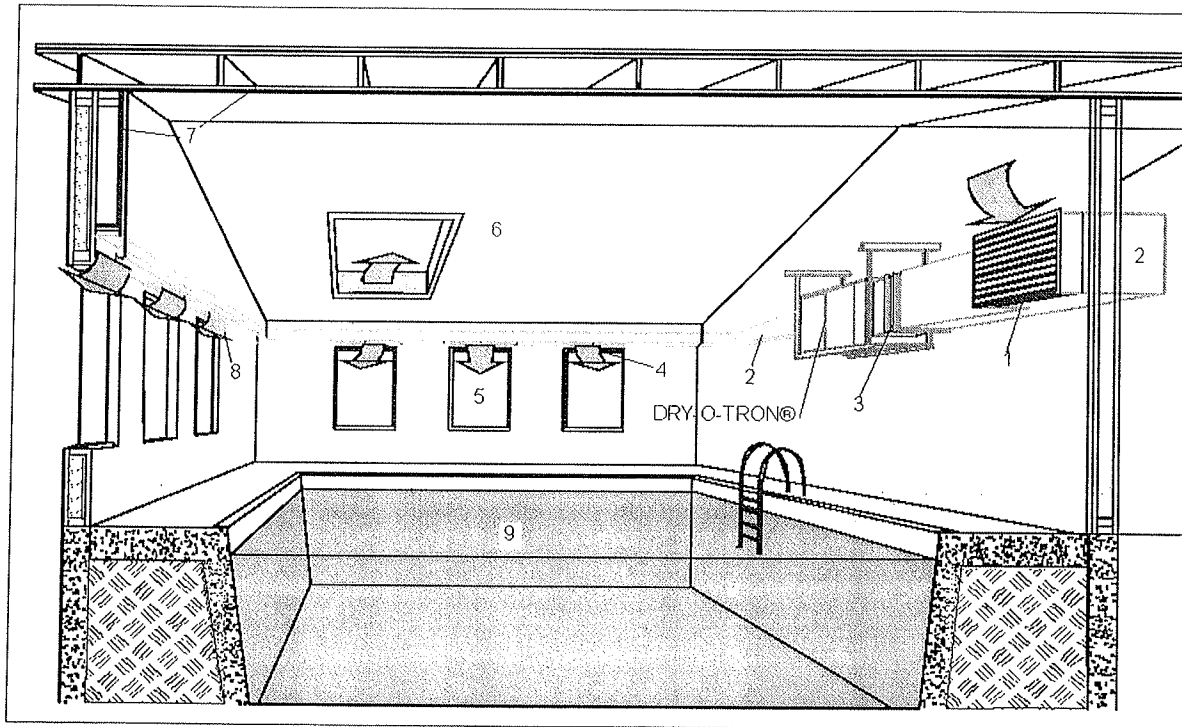
Recommended Minimum Temperatures for Interior Surfaces

Relative Humidity %	Room Dry Bulb Temperature °F				
	72	76	80	84	88
	<b>Recommended Interior Surface Temperature to Prevent Condensation (°F)</b>				
40	51	55	59	62	65
50	57	61	65	68	72
60	62	66	70	73	77

INSTALLATION

Data subject to change without notice.

Owner's Manual      DS/DSV/RS/DB/RB Series Dehumidifier  
 Overhead Supply Duct      Air Distribution      Installation



1. Locate the return air inlet 10 to 15 ft above floor for proper air circulation and to prevent blocking of the grille.
2. Where an elbow is required, use acoustic insulation up to the elbow to eliminate air movement noise. (See also **Duct Design**.)
3. Always install flexible duct connections.
4. Linear diffusers must cover entire width of window
5. Blanket entire window with supply air
6. Skylights are not recommended since condensation on skylights is difficult to control.
7. A vapor barrier in all walls and ceilings is necessary. Dehumidification will not prevent the condensation of liquid water inside cold walls.
8. Direct air at glass surfaces from close range for glass mounted high on walls.
9. Do not direct air over pool surface.

INSTALLATION

# UNITS WITH AIR-COOLED AIR CONDITIONING ONLY ASSEMBLING AND BRAZING CONDENSER TUBES

**IMPORTANT:**

Contact Dectron before exceeding the maximum tube length specified on the unit nameplate. Contact Dectron before changing the tube size specified on the unit nameplate. (See Product Description - Unit Nameplate.)

**IMPORTANT:**

Never allow dirt or other foreign materials to enter the remote condenser or the tubes connecting it to the DRY-O-TRON®. Foreign material may damage valves and other components.

If the insides of the tubes are contaminated with dirt, oil,

sludge, rust, or other materials, then they must be thoroughly cleaned.

**IMPORTANT:**

Never allow liquid water to enter the remote condenser or the tubes connecting it.

Water must be removed from the remote condenser and the tubes that connect it to the DRY-O-TRON®. Evacuation will take much longer if liquid water is present.

**Note:** Some DRY-O-TRON® units may have two pairs of tubes to the remote condenser.

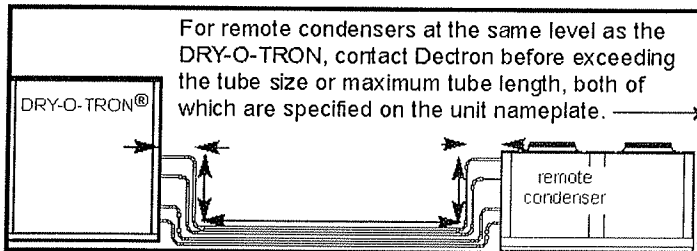
Connect the refrigerant tubes between the DRY-O-TRON® and the remote chiller. Use only clean

Type ACR copper tube. Silver braze the copper tube joints using BCuP filler. Soft solder is subject to long-term failure. If flux must be used, use only enough flux to solder. Excess flux can contaminate the refrigeration system and damage components

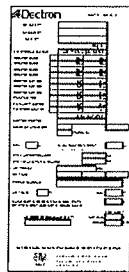
During silver brazing the inside of the tube must be protected from oxidation by flooding the tube with an inert gas such as nitrogen, argon, or carbon dioxide. Silver brazing copper tubes with air inside will produce a flaky copper oxide scale that can contaminate the refrigeration system and damage components.

**IMPORTANT:**

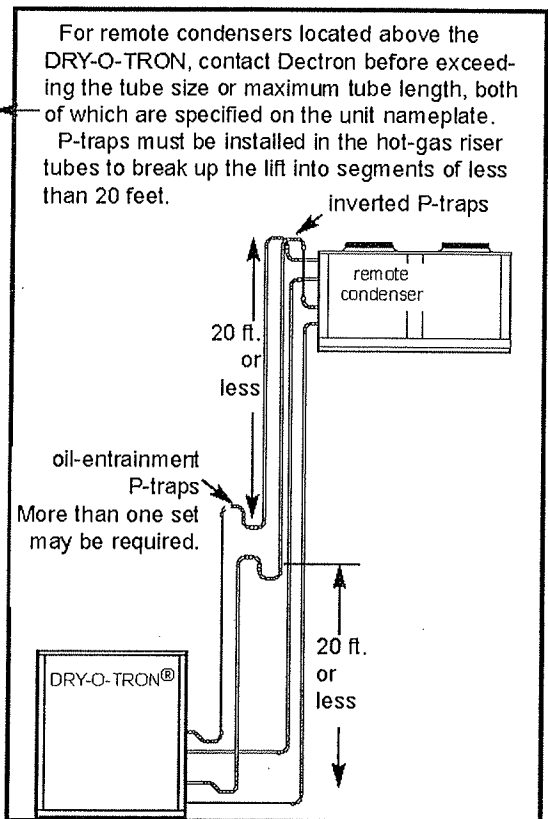
Check carefully for leaks.



Contact Dectron for remote condensers located below the DRY-O-TRON.



See Product Description Unit Nameplate



INSTALLATION



**UNITS WITH WATER-COOLED OR FLUID-COOLED AIR CONDITIONING ONLY**

**IMPORTANT:**

Contact Dectron before changing the temperature range or flow rate of the water or fluid. (See Product Description - Unit Nameplate.)

**IMPORTANT:**

Never allow dirt or other foreign materials to enter the tubes connecting to the DRY-O-TRON®. Foreign material may cause damage to valves and other components.

If the insides of the tubes are contaminated with dirt, oil, sludge, rust, or other materials, then the pipes must be thoroughly cleaned.

Where connection must be made to metal tube other than copper tube, install a dielectric union between the different tubes to reduce corrosion.

If flux must be used, use only enough flux to solder. Excess flux

can contaminate the heat transfer fluid.

If tubes are silver-soldered, the inside of the tube must be protected from oxidation by flooding the tube with an inert gas such as nitrogen, argon, or carbon dioxide. Silver soldering copper tubes with air inside will produce a flaky copper oxide scale that can contaminate the refrigeration system and damage components.

**IMPORTANT:**

Constant water or fluid flow is essential. All pumps, cooling towers, fans, etc., involved in cooling the water or fluid must be enabled whenever the DRY-O-TRON® is operational. Do not allow a timer or other device to inhibit operation at any time the DRY-O-TRON® is operational.

**IMPORTANT:**

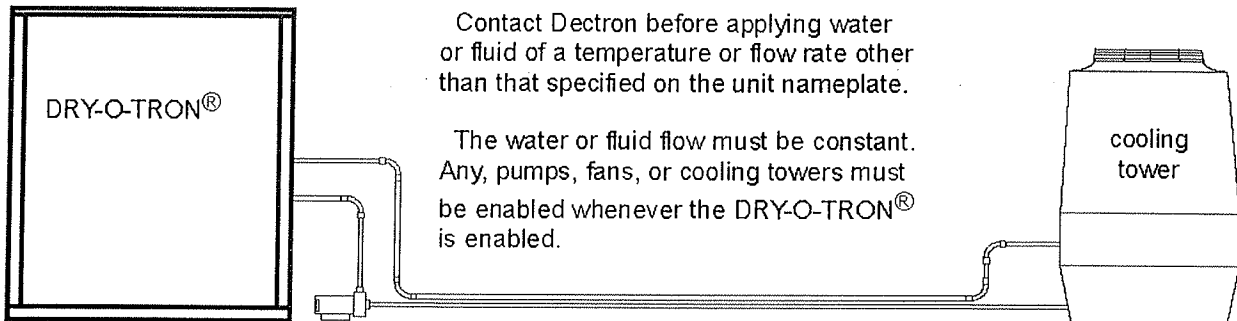
Cooling water must be protected from freezing if the water flow could be interrupted during low ambient temperatures.

**IMPORTANT:**

If a fluid other than water is used for condenser cooling, use only the type and concentration specified on the unit nameplate. (See Product Description - Unit Nameplate.)

**Water or Fluid Pressure Switch**

The flow pressure switch (see field wiring diagram) must be adjusted at installation. Adjust the switch to make as the flow rate approaches normal and to break as the flow rate decreases to less than 1/2 of normal. See Startup - Pre-Startup Adjustments.



Contact Dectron before applying water or fluid of a temperature or flow rate other than that specified on the unit nameplate.

The water or fluid flow must be constant. Any, pumps, fans, or cooling towers must be enabled whenever the DRY-O-TRON® is enabled.

Port locations may vary. See the unit port labels.

INSTALLATION

**WATER-HEATED, GLYCOL-HEATED, OR STEAM-HEATED UNITS ONLY**

Connect the heating fluid tubes between the DRY-O-TRON® and the hot fluid source. Where connection must be made to metal tube other than copper tube, install a dielectric union between the different tubes to reduce corrosion.

For units heated by glycol solution do not use galvanized pipe or tube.

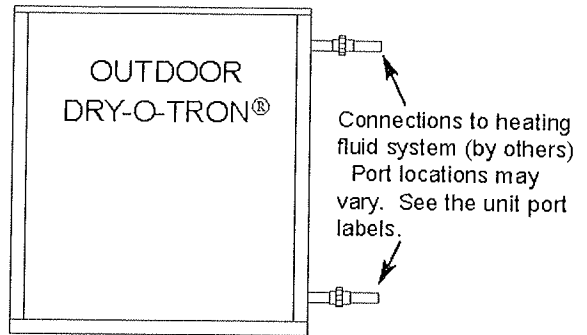
Where copper tubes are soft soldered, use only enough flux to solder. Excess flux can contaminate the heat transfer fluid.

Where copper tubes are silver soldered, the inside of the tube must be protected from oxidation during soldering by flooding the tube with an inert gas such as nitrogen, argon, or carbon dioxide.

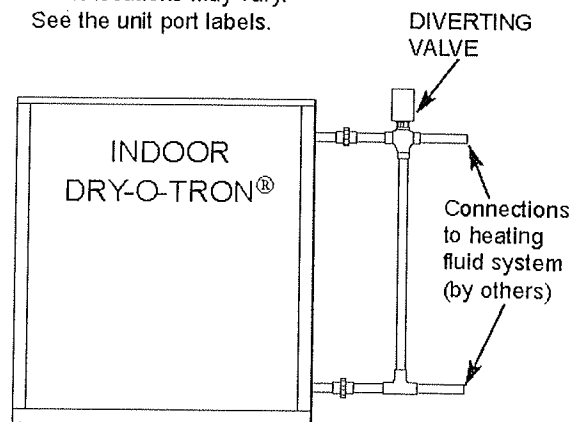
Indoor DRY-O-TRON® units with integral steam or hot water heating have external valves (supplied by Dectron, installed by others). Install and connect this valve with its accompanying tube assembly as shown.

**IMPORTANT!**

See *Installation - Wiring - Heating Valve* for proper methods of wiring this valve.



Port locations may vary. See the unit port labels.



INSTALLATION

Condensate Drains

Piping

Installation

**Important!**

The condensate drain must be installed and the P-trap must be filled before starting the unit.

**Δ Select materials**

Ordinary schedule 40 PVC or ABS plastic pipe is adequate in most cases. Do not reduce the pipe size below that provided on the unit.

**Δ Install P-trap**

An adequate P-trap must be installed. If a P-trap is provided with the unit, use it. If one is not provided, use the recommended size P-trap. The P-trap must be sized for a negative 1.5 inch water column pressure in the DRY-O-TRON® cabinet.

For long runs or possible unintentional traps, a vacuum breaker on the outlet side of the P-trap may be necessary. Follow standard procedures.

**Δ Route drain pipe**

Route the drain pipe so that the only trap is the P-trap. In horizontal runs, slope the pipe downward at least 1/4" per foot (2 cm per meter).

Deliver the condensate to a suitable point. Condensate may be returned to the pool for water savings, or it may be sent to a drain. Check local codes for allowable procedures. Expect many gallons of water per hour, year-round.

**Δ Fill P-trap**

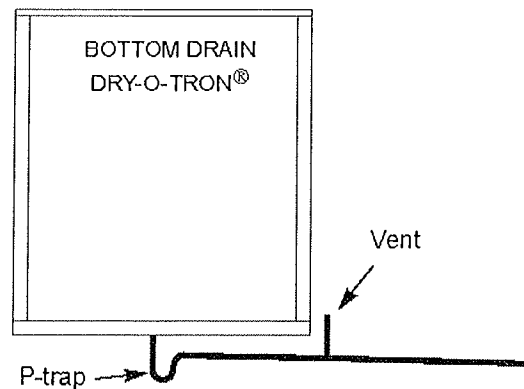
To prevent air from being drawn through the condensate drain pipe, the P-trap must be filled with water before starting the unit blowers. Failure to do this will cause the drain pan to overflow during operation.

**Δ Condensate pump**

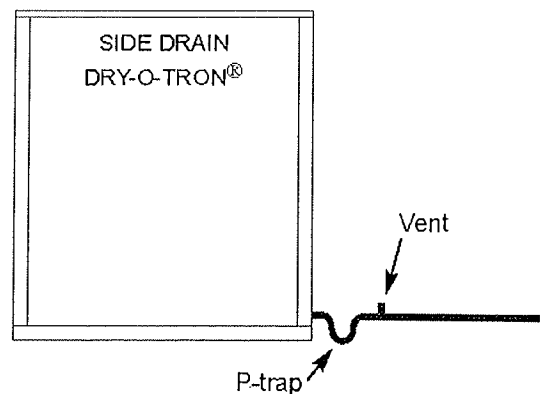
If a condensate pump must be used, be sure it has enough pressure and volume capability. If the condensate is to be delivered to a pipe that might be pressurized above atmospheric pressure, install a check valve to prevent backflow.

Some DRY-O-TRON® units have bottom condensate drains. The requirements for bottom drains is covered under **Installation - Isolators and Drain**, since drain arrangements may have to be made before the unit is placed.

Depending on conditions, bottom drains may have to be protected against freezing. Water flows in drains year-round.

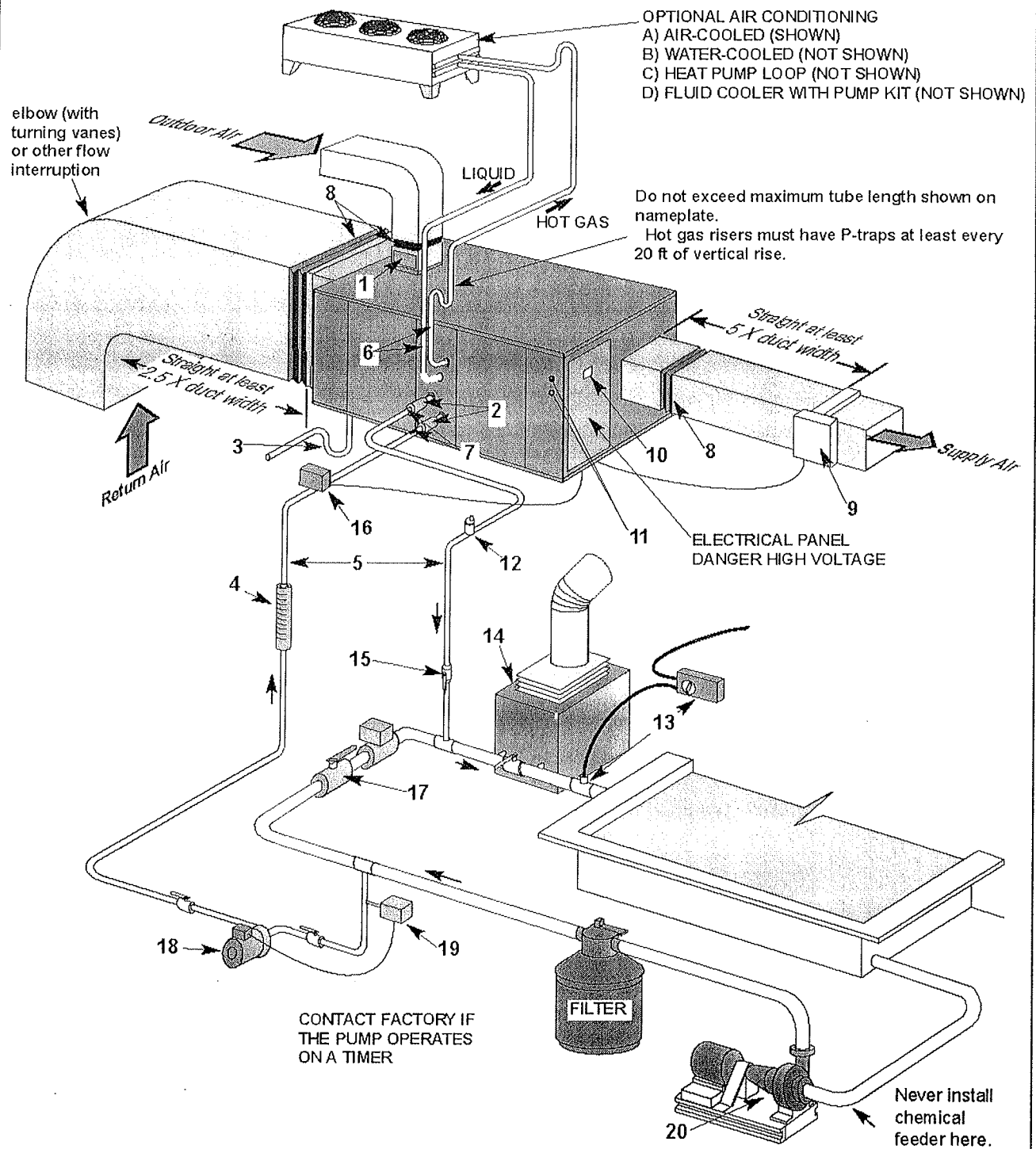


Some DRY-O-TRON® units have side condensate drains. Use the same pipe materials and methods used for bottom condensate drains. **Side drains on outdoor units must be protected from freezing.** Water flows in drains year-round.



INSTALLATION

DRY-O-TRON® Energy Recycling Indoor Pool Environment Control



INSTALLATION

Contents

Startup

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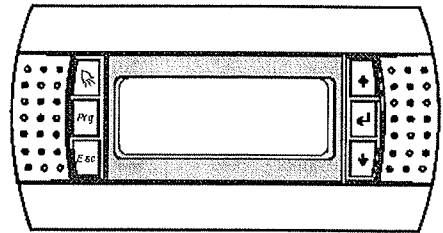
STARTUP







Set Display Address

Startup

To set the display address, follow these instructions.

- 1. If safe to do so, turn on the electric power to the unit.  
If the display shows "Humidity" and other information, no further action is needed. If not, proceed to step 2.




- 2. Simultaneously press and hold the , , and  buttons for at least five seconds. The screen at right will appear, where **aa** and **bb** are numbers.
- 3. Press . The cursor will move to **aa**, as shown.
- 4. Press  until **aa** equals 0.
- 5. Press . Note that "I/O Board address : bb" disappears. The screen at right appears briefly, followed by the unit default screen.

blinking cursor

```

Display address
setting ..... aa
I/O Board address : bb
  
```

```

Display address
setting ..... 
I/O Board address : bb
  
```

```

Display address
setting ..... 0
  
```

```

Display address
changed
  
```

Default Screen

```


HUMIDITY  aa / bb %
ROOM AIR  cc / dd F
XXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXX
  
```

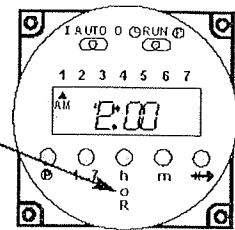
Set External Clock

Pre-Startup Adjustments




Startup

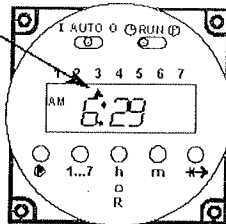
Some units may be equipped with an external seven-day time clock to increase outdoor air intake during Occupied periods. In this case the clock must be set for local time and for occupied periods.

If mistakes are made while programming, all settings can be erased by pressing **R**. If the display shows , use a short piece of wire to press **R**, and start over.







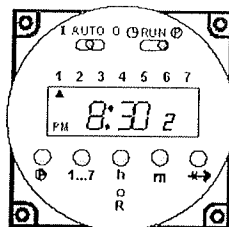
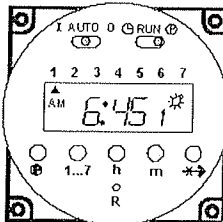
**A. Set present day and time-of-day**

1. Move **RUN** switch to **O** () ()
2. Press **1...7** to move the indicator under the day of the week. (ex. **3** for Wednesday)
3. Press **h** to set the hour of the day. (ex: 6 AM)
4. Press **m** to set the minutes past the hour. (ex: 6:29 AM)
5. Move **RUN** switch to **RUN** ()
6. Colon will blink. Clock is now set to day and time.





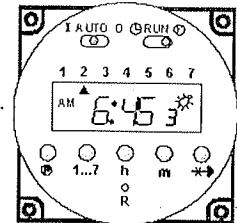
**B. Set Occupied period for Mondays.**

1. Move **RUN** switch to **P** () ()
2. Press **1...7** to move the pointer under day **1** for Monday. The **1** indicates the first timer action.  indicates Occupied.
3. Press **h** to set the hour of the beginning of the Monday Occupied period. (ex: 6 AM)
4. Press **m** to set the minute of the beginning of the Monday Occupied period. (ex: 6:45 AM)
5. Press **P** to set the end of the Monday Occupied period. The **2** indicates the second timer action. The  disappears to indicate Unoccupied.
6. Press **h** to set the hour of the end of the Monday Occupied period. (ex: 8 PM)
7. Press **m** to set the minute of the end of the Monday Occupied period. (ex: 8:30 PM)







**C. Set Occupied period for other days.**

1. Press **P** to change to timer action 3.
  2. Press **1...7** to move the indicator under 2 (for Tuesday).
  3. Repeat steps B3 through B7, using the appropriate times for Tuesdays.
  4. Repeat above steps for other days of the week.
  5. When the Occupied periods for all days have been set, move **RUN** switch to **RUN** ()
- The **AUTO** switch should remain on Auto () 6. Occupied periods are now set and become effective on the next Occupied period.




**Manual operation**

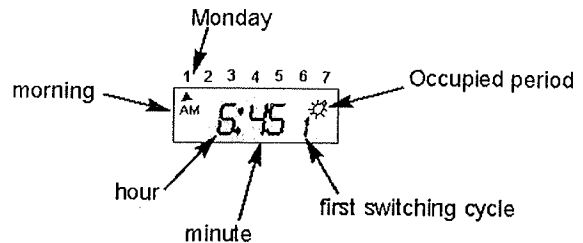
To force an Occupied period, move the **AUTO** switch to "1" () . Leave the **RUN** switch on **RUN** () .

To force an Unoccupied period, move the **Auto** switch to **O** () . Leave the **Run** switch on **Run** () .

To skip the next Occupied period, press **→**.

**Indication of Occupied period**

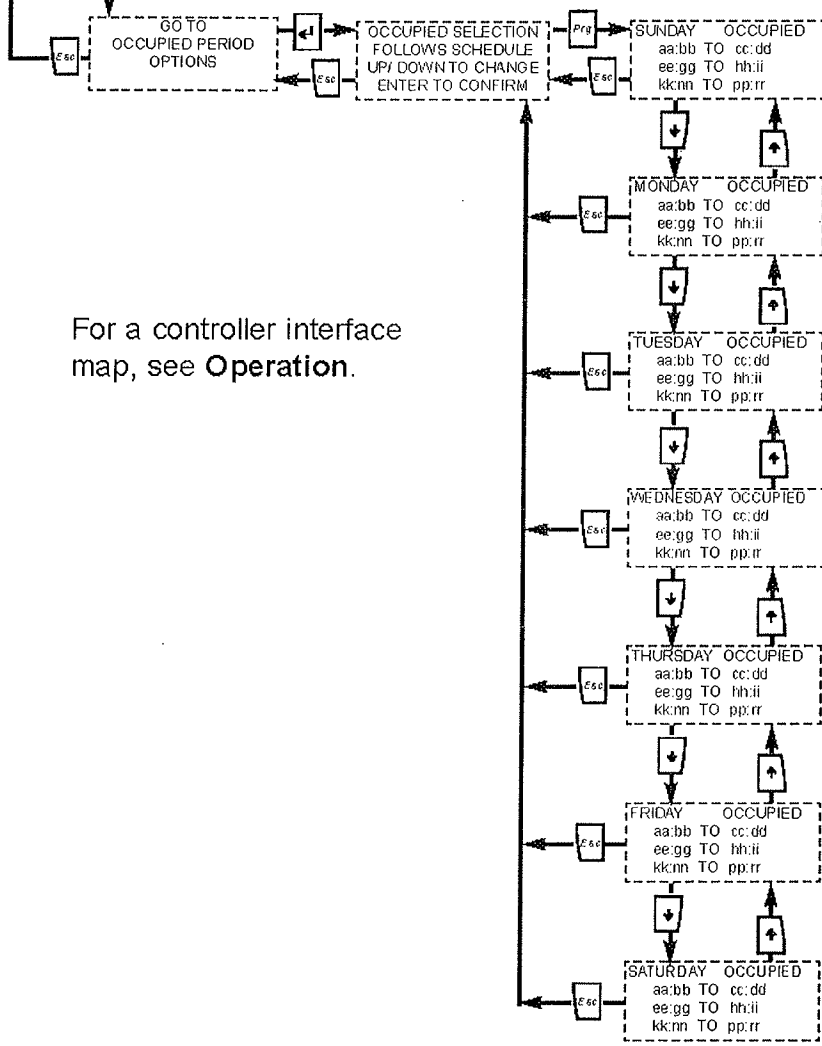
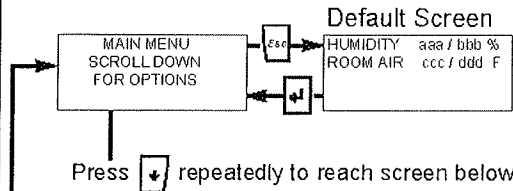
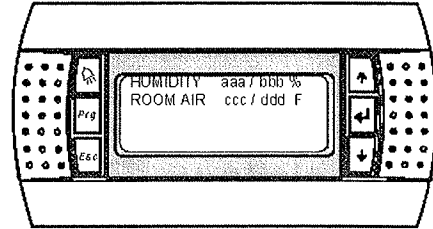
The symbol  in the upper right corner of the display indicates that the present time is in an Occupied period. ex:



STARTUP

Set Occupied Periods Internal Clock Pre-Startup Adjustments Startup

Some units may use an internal seven-day time clock to increase outdoor air intake during Occupied periods. In this case the times of the occupied periods must be set as shown here. For external clocks, see **Startup - Pre-Startup Adjustments - Set External Clock**.



Each day of the week can have up to three periods of occupation. In the screens at left, aa = hour of beginning of first occupied period bb = minute of beginning of first occupied period cc = hour of end of first occupied period dd = minute of end of first occupied period

ee = hour of beginning of second occupied period gg = minute of beginning of second occupied period hh = hour of end of second occupied period ii = minute of end of second occupied period

kk = hour of beginning of third occupied period nn = minute of beginning of third occupied period pp = hour of end of third occupied period rr = minute of end of third occupied period

For a controller interface map, see **Operation**.

For each day, press as necessary to move the cursor to the desired value. Press or to change the value. Press to return to previous screens. If a period is not necessary, set beginning hour, beginning minute, ending hour, and ending minutes to zero.

STARTUP



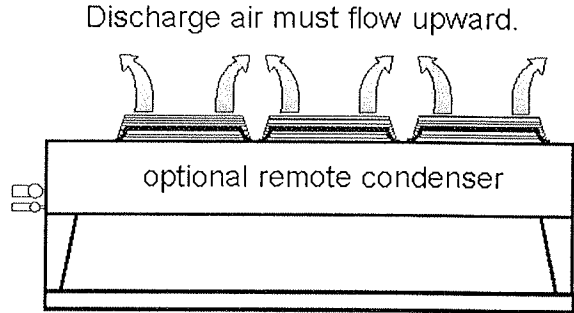
Pre-Startup Adjustments

Startup

**CONDENSER FAN ROTATION (units with air-cooled air conditioning option only)**

Units with optional air-cooled air conditioning will have a remote condenser. The condenser fans must rotate so as to produce an upward air discharge as shown.

Single phase fans will inherently turn the proper direction. If three phase fans turn the wrong way, a qualified person should disconnect the branch circuit and interchange any two wires on the power inlet lugs in the condenser control enclosure. Do not move any factory installed wires.

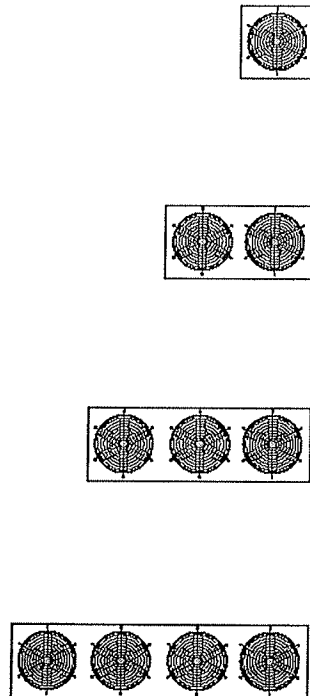


**CONDENSER FAN THERMOSTATS (units with air-cooled air conditioning option only)**

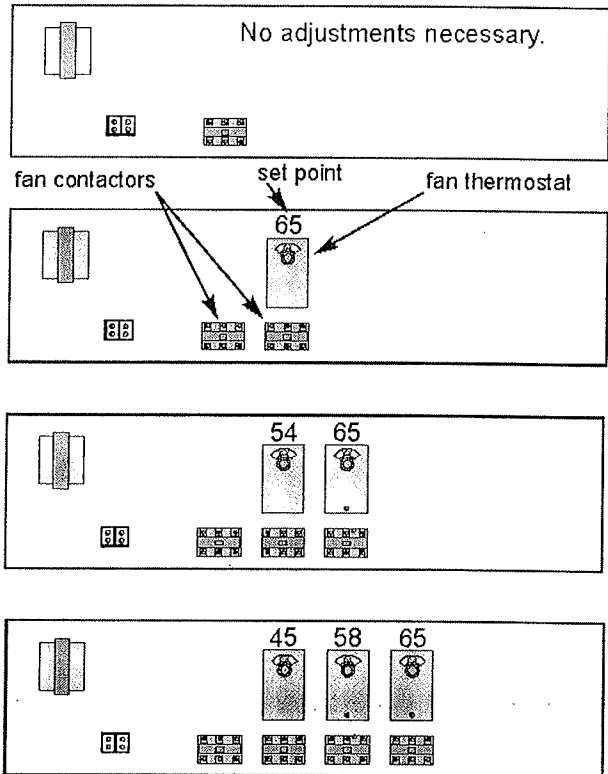
Units with optional air-cooled air conditioning will have a remote condenser. Some remote condensers may have more than one fan. Condensers with multiple fans have a minimum number of fans that run continuously whenever the DRY-O-TRON® is in cooling mode. Any other fans will be controlled by thermostats sensing outdoor air temperature.

The thermostats must be adjusted at installation, using the diagrams below and on the next page.

FAN ARRANGEMENT



CONDENSER CONTROL ENCLOSURE



STARTUP

Pre-Startup Adjustments

Startup

**CONDENSER FLUID FLOW**  
(units with fluid-cooled air-conditioning option only)

Units with optional fluid-cooled air conditioning must have a constant flow of fluid of the correct temperature.

Unit Size	Flow (GPM) Water @ 90°F
010	6
015	6
020	8.5
030	15
040	20
042	17
050	20
060	30
062	30
080	40
082	40
100	40
102	40
120	60
122	60
150	60
152	80
162	80
182	80
202	100
242	120
282	140
362	140
482	240
562	280

**Dry-Cooler® FLUID FLOW**  
(units with Dry-Cooler® cooled air-conditioning option only)

Units with Dry-Cooler® cooled air conditioning must have a constant flow of fluid of the correct temperature.

Unit Size	Flow (GPM) 50% Eth. Glycol Solution @ 110°F
010	8
015	10
020	14
030	20
040	28
042	28
050	36
060	45
062	40
080	54
082	56
100	73
102	73
120	94
122	94
150	107
152	107
162	127
182	145
202	160
242	178
282	210
362	276
482	375
562	437

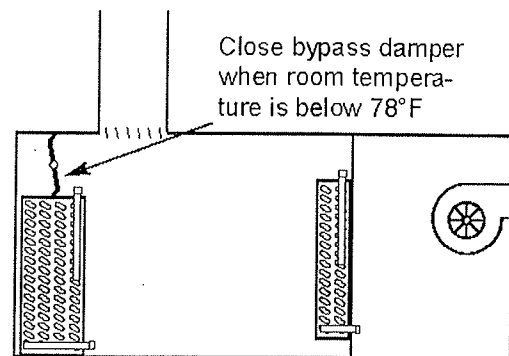
**POOL WATER FLOW**

Units must have a constant pool water flow rate. If a flowmeter is not available, see **Adjustments** later in this section.

Unit Size	Flow (GPM) Water @ 85°F
010	6
015	6
020	6
030	8.5
040	8.5
042	12
050	15
060	20
062	17
080	20
082	17
100	20
102	26
120	20
122	30
150	40
152	40
162	40
182	40
202	40
242	60
282	80
362	80
482	120
562	160

**Units with MANUAL EVAPORATOR BYPASS DAMPER only**

Some units may have manual evaporator bypass dampers. In this case the damper must be closed completely as long as the room temperature is below 78°F. If the room temperature at startup is above 78°F, a manual evaporator bypass damper should be fully open.



STARTUP

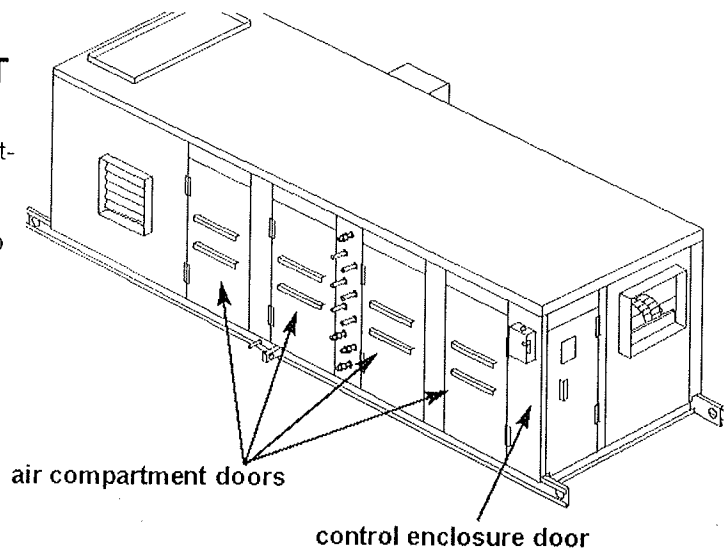
## Pre-Startup Adjustments

## Startup

**CLOSE ALL AIR COMPARTMENT DOORS AND ACCESS PANELS**

The control enclosure door is not an air compartment door.

When the blower starts, the strong suction on the air compartment could cause an open door to close suddenly. Be sure to close and secure the doors before starting the blower.

**Airflow**

The return air flow rate in CFM should be within  $\pm 10\%$  of the amount specified on the unit nameplate. See **Installation - Air Distribution - Adjust Airflow**.

**Units with Economizer or Intelligent Energy Saver -**

The outdoor conditions, called "changeover point", which trigger Economizer operation are preset at the factory based on data supplied with the order. If the changeover point must be changed, consult Dectron or a Dectron-certified service technician.

The minimum outdoor air intake flow rate during Occupied periods must be set at installation - see **Installation - Air Distribution - Adjust Airflow**. To adjust this value consult Dectron or a Dectron-certified technician.

The indoor air exhaust flow rate must be set at installation, see **Installation - Air Distribution - Adjust Airflow**. To adjust this value, consult Dectron or a Dectron-certified service technician.

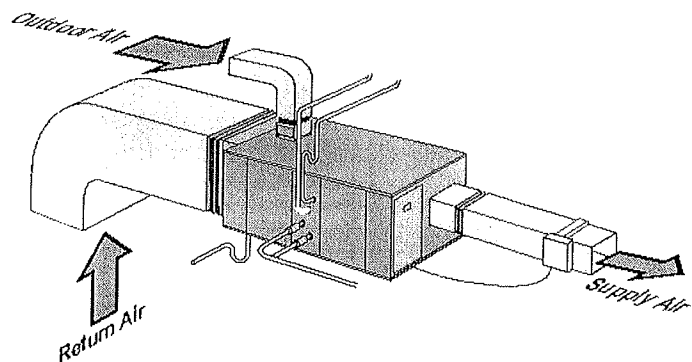
**Units with SmartSaver -**

The Outdoor air intake flow rate must be set at installation, see **Installation - Air Distribution - Adjust Airflow**. This flow rate is determined by ventilation requirements and may be found in the unit submittal information. This flow rate should not exceed 15% (or 30% with optional air conditioning) of the return air flow rate. To adjust this value, consult Dectron or a Dectron-certified service technician.

The room exhaust air flow rate must be set at installation, see **Installation - Air Distribution - Adjust Airflow**. This flow rate should be 110% of the outdoor air intake flow rate above. To adjust this value, consult Dectron or a Dectron-certified service technician.

**Units with Purge Mode**

The time delay for purge mode is preset at the factory to exhaust one complete room volume in 15 minutes. If this delay must be adjusted, consult Dectron or a Dectron-certified technician.



STARTUP

Pre-Startup Checklist

Startup

Print your initials in the boxes to indicate completion. Print "N/A" for items which are not applicable to the installation.

Natatorium

Confirm that the natatorium walls and ceiling have been adequately insulated and have a proper vapor barrier (see Natatorium - Moisture Migration)

Confirm that any windows are installed and so constructed as to allow proper air flow over the glass (see Natatorium - Moisture Migration)

Confirm that the pool has been filled and that the pool water chemistry is as specified by the National Pool & Spa Institute (see Natatorium - Pool Water Chemistry)

Confirm that the pool operator has been made aware of the need for proper maintenance of the pool water chemistry.

Confirm that adequate space has been left around the DRY-O-TRON® (see Installation - Unpacking and Locating).

For indoor DRY-O-TRON® units, confirm that chemicals are not stored in the same room with the DRY-O-TRON®.

Confirm that no construction dust or other debris is in the return duct.

Confirm that no construction dust or other debris will be drawn into the return duct or the outdoor air duct (if any).

your initials

your initials

your initials

your initials

your initials

your initials

your initials

your initials

Piping

Confirm that all specified air vents are installed and operating.

For units with air-cooled air conditioning, confirm that refrigerant piping is installed and free of leaks.

For units with air-cooled air conditioning, confirm that the condenser and tubes have been evacuated to 500 microns of mercury or less.

For units with water- or fluid-cooled air conditioning, confirm that the water or fluid flow is within tolerance according to the unit specifications.

Confirm that any heating fluid system is installed, free of leaks, and has the proper flow and temperature. See Installation - Isolators and Drain.

Confirm that the pool water piping to the DRY-O-TRON® is installed and free of leaks.

Confirm that the pool water is flowing at the proper rate (see Installation - Piping - Pool Water).

Confirm that the condensate drain is properly connected with a filled P-trap, is free of leaks, and works.

For units requiring a condensate pump, confirm that the pump is operating.

For units with boilers, confirm that the fuel gas is supplied between 7" W.C. and 14" W.C., or at a special pressure specified at time of order. (See Installation - Piping - Boiler.)

For units with boilers, confirm that the fuel gas piping is correctly sized. (See Installation - Piping - Boiler.)

your initials

your initials

your initials

your initials

your initials

your initials

your initials

your initials

your initials

your initials

your initials

Wiring

Confirm that the voltage to be applied to the DRY-O-TRON® corresponds to that specified on the unit nameplate and to the other requirements of Installation - Wiring - Power.

For units with air-cooled air conditioning, confirm that the voltage applied to the remote condenser corresponds to that specified on the condenser nameplate.

Confirm that the size of the wire supplying electric power to the DRY-O-TRON® is adequate for the circuit ampacity shown on the nameplate.

For long lengths of power wiring or marginal applied voltage, confirm that the wire size is adequate for less than 10% voltage drop under compressor starting current.

Confirm that only copper wire was used for any connections to the DRY-O-TRON®.

Confirm that the unit is properly grounded.

Confirm that all electrical connections have been checked for tightness and re-torqued as necessary.

Confirm that all electrical enclosures are clean and dry.

For 3-phase units, confirm that the phase sequence is correct for proper blower rotation. See Setup - Airflow.

Confirm that the control signal wiring is complete, as shown in the unit field-wiring diagram.

your initials

your initials

your initials

your initials

your initials

your initials

your initials

your initials

your initials

your initials

Model \_\_\_\_\_  
S/N \_\_\_\_\_  
Ref \_\_\_\_\_

Completed by \_\_\_\_\_ Ph. ( ) \_\_\_\_\_ - \_\_\_\_\_

STARTUP

Enable Operation

Startup

**IMPORTANT!**

This energy recycling dehumidification system has been completely tested under design conditions at the factory. Start-up must be performed by a qualified factory-trained service and installation technician.

Once start-up is completed, all portions of the "Start-up Report and Warranty Registration" form must be completely filled in and a copy must be sent to the Dectron representative or to the Dectron factory in order to register and validate the warranty.

**Important!**

For units installed in natatoria, starting the DRY-O-TRON® when the pool water is cold is always a two-stage procedure. Be prepared to return to the site to do the final adjustments when the pool water and pool enclosure are at design conditions.

Do NOT turn on the electric power unless the power supply voltage matches that specified on the unit nameplate. Be certain that there is no construction dust in the space or in the return duct.

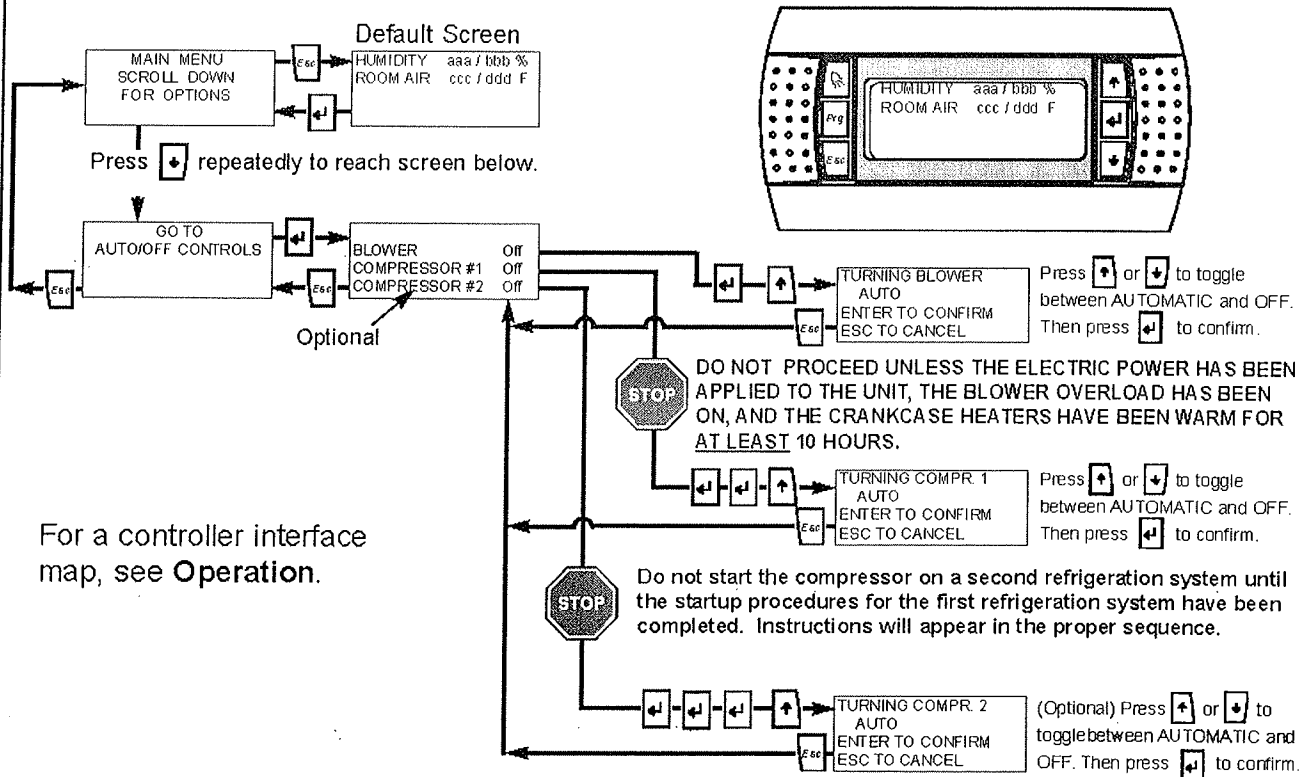
**1. Apply electric power**

If the disconnect switch for the remote condenser is not already ON, turn it ON now. For units with manual reset overload(s) for the blower motors, press the START button(s) on the overload(s). This starts the compressor crankcase heaters. Allow no less than 10 hours of crankcase heater operation before enabling a compressor.

2. For units with service lights and/or receptacles, turn ON the disconnect switch for the DRY-O-TRON® service circuit.

3. In the DRY-O-TRON® electrical enclosure, press START on the blower motor overload (if any). Press START on the compressor overload(s) (if any).

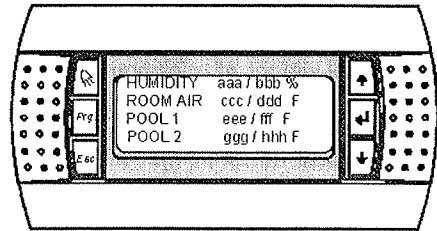
4. Follow the steps below to enable the blower and compressor(s). If prompted for a password on units made before 4/2005, enter 1793. For units made after 4/2005, enter 17 or 1793.



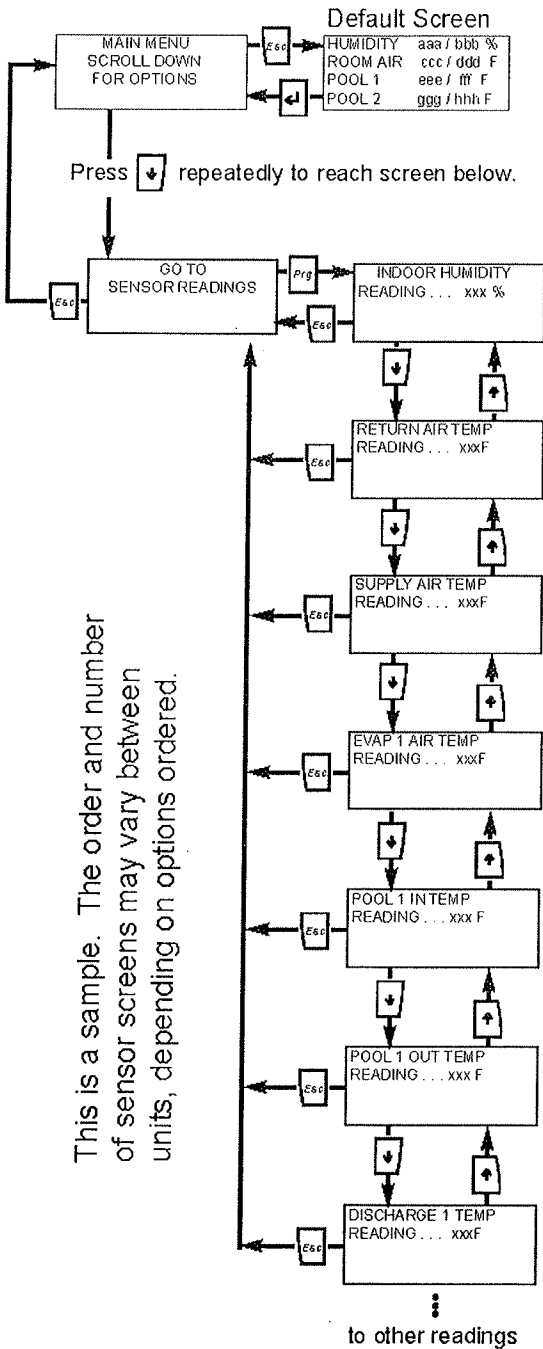
For a controller interface map, see **Operation**.

STARTUP

The values of some sensor signals are displayed on the default screen, as at right.  
To read all sensors, follow the steps below:



For a controller interface map, see **Operation**.



This is a sample. The order and number of sensor screens may vary between units, depending on options ordered.

This screen displays the relative humidity of the room air, as measured at the return duct

This screen displays the temperature of the room air, as measured at the return duct

This screen displays the temperature of the supply air, as measured at the DRY-O-TRON® supply blower.

This screen displays the temperature of the air leaving the evaporator of the first refrigeration circuit.

This screen displays the temperature of the pool #1 water entering the DRY-O-TRON®.

This screen displays the temperature of the pool #1 water leaving the DRY-O-TRON®.

This screen displays the temperature of the hot refrigerant gas leaving the #1 compressor. This is important to a proper startup. See **Startup - TXV Adjustment**.

STARTUP

TXV Adjustment

Startup

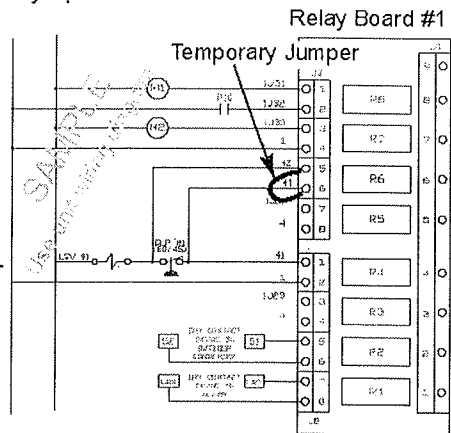
The expansion valve(s) must be adjusted at startup, since airflow affects the evaporator loading. To obtain proper operation and long life, it is important to adjust the expansion valve(s) as described below.

➡ **Do not attempt to adjust the expansion valve based on evaporator superheat.** ⬅

Adjust circuit #1 expansion valve(s)-

1. For units with air-cooled air conditioning, be sure that the specified additional refrigerant has been added. (See **Product Description - Unit Nameplate, Installation - Piping - Refrigerant, and Startup - Add Refrigerant.**)
2. Be sure that the air flow has been adjusted to the value shown on the unit nameplate. (See **Product Description - Unit Nameplate.**)
3. Be sure that the room temperature and relative humidity are at the values shown on the unit nameplate. (See **Product Description - Unit Nameplate.**)
4. If the evaporator bypass damper is manually operated, be sure that it is fully open.
5. Close the access panels or doors.

6. In the unit control enclosure, place a temporary jumper between wire 41 and wire 42 (across the pressure switch labeled "CLP") (See unit wiring diagram.)
7. If the unit model number ends in "2", e.g. DS042, RB282, there will be two refrigeration circuits. Identify the expansion valve(s) associated with the first circuit.
8. Start the unit per the instructions given in **Startup - Enable Operation.**
9. If the unit does not operate in pool heating mode (status message POOL 1 HEAT ON, see **Operation - Controller Messages.**), then temporarily increase the pool water temperature set point by at least 5°F (3°C) to cause the unit to operate in full pool heating mode. (See **Startup - Adjust Set Points**) The compressor should run.
10. Be sure that the refrigerant sight glass is completely full of liquid, with no bubbles. If bubbles are present, return to step 1 or contact Dectron.



11. Allow the unit to run in pool heating mode for at least 20 minutes, then read DISCHARGE 1 TEMP from the controller as shown.

This temperature should be between 180°F (82°C) and 200°F (93°C).

12. (a) If DISCHARGE 1 TEMP is below 180°F (82°C), close the expansion valve(s) 1/2 turn at the time, allowing at least 15 minutes between adjustments, until DISCHARGE 1 TEMP is between 180°F (82°C) and 200°F (93°C).
- (b) If DISCHARGE 1 TEMP is above 200°F (93°C), open the expansion valve(s) 1/2 turn at the time, allowing at least 15 minutes between adjustments, until DISCHARGE 1 TEMP is between 180°F (82°C) and 200°F (93°C).

adjustments, until DISCHARGE 1 TEMP is between 180°F (82°C) and 200°F (93°C).

(c) For multiple expansion valves, try to keep the average valve-bulb temperatures as near the same as possible, while meeting the requirements of (a) and (b) above.

13. Allow the DRY-O-TRON® to operate continuously for at least 1 hour after the last adjustment, then check to be sure DISCHARGE 1 TEMP is between 180°F (82°C) and 200°F (93°C).

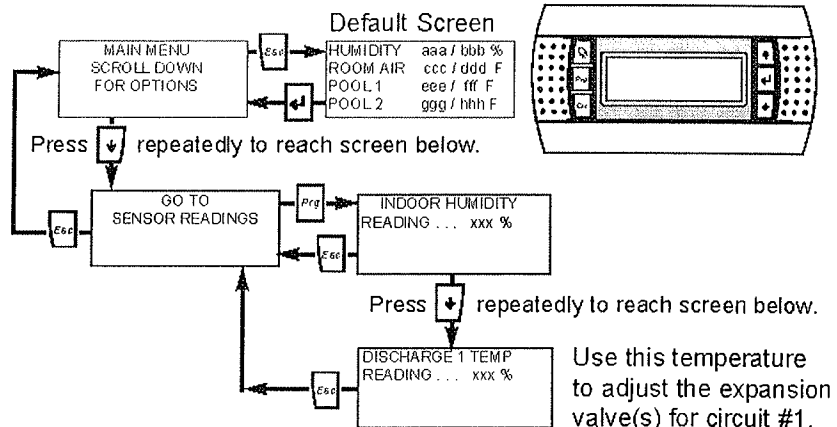
14. Replace the expansion valve caps.

15. Return the set points to normal, as noted on the unit nameplate (see **Product Description - Unit Nameplate**).

16. Remove the temporary jumper between wire 41 and wire 42.

17. Close the access panels or doors.

18. If unit model number ends in "2", e.g. DS042, RB282, go to next page.



STARTUP

## Adjust Flow Switches

## Startup

The pool water flow rate(s), the water-cooled condenser flow rate(s) (if any), and the DryCooler® flow rate(s) (if any) must be near the values shown in **Startup - Pre-Startup Adjustments**.

**Adjusting pool water flow rate(s)-**

Flow rates are most easily set with the recommended flow meter (see **Installation - Piping**). If this is not possible, the flow rate can be set by waiting until the space and pool water are at design temperatures, then

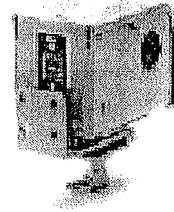
1. Reduce the relative humidity set point to operate the unit in Dehumidification.
2. Increase the pool water temperature set point to operate the unit in Pool #1 Heating.
3. Wait at least 20 minutes.
4. Read the entering pool #1 water temperature (see **Startup - Read Sensors**).
5. Read the leaving pool #1 water temperature (see **Startup - Read Sensors**).
6. Subtract the entering pool #1 water temperature from the leaving pool #2 water temperature. The difference should be 12°F to 20°F. Adjust the water flow until this condition is reached.
7. Check the temperature difference again twenty minutes after the last adjustment to be sure it is stable.

Repeat steps 1 - 7 for a second pool (if any).

**Adjusting the pool water pressure switches:**

The pool water pressure switch informs the unit controller that pool water flow is present. To adjust this pressure switch, first adjust the water flow as shown above, then

1. Turn the pressure switch adjusting screw counter-clockwise until the pressure switch contacts open. The DRY-O-TRON® controller will stop Water Heating Mode and will show a low water flow alarm.
2. Slowly turn the pressure-switch adjusting screw clockwise until the pressure switch contacts just make, then turn the screw an additional 1/2 turn clockwise.
3. Stop the pump and confirm that the pressure switch responds to the drastic reduction in water flow.
4. Re-adjust as necessary for proper operation.

**Units with water-cooled or fluid-cooled condensers**

Repeat the above steps for the condenser water flow rate and fluid flow switches. See the recommended flow rates in **Startup - Pre-Startup Adjustments**.



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STARTUP

# DRY-O-TRON® DS Series Start-up Report & Warranty Registration

Warranty void unless completed and a copy returned to Dectron within 1 week after start-up!

Installation Name .....

Installation Address .....

Dectron Representative .....

Model # ..... Serial # .....

Compressor Serial # ..... Blower Belt Size .....

Electrical power	L1 - L2	L2 - L3	L1 - L3	Nameplate
Blower amperage				
Blower voltage				
Compressor amperage				
Compressor voltage				

<b>Proper air distribution provided?</b> (See Installation - Air Distribution) <input type="checkbox"/>	<b>Condensate drain connected and P-trap installed and filled?</b> (See Installation - Isolators & Drain) <input type="checkbox"/>	<b>tightness?</b> (See Installation - Wiring - Power) <input type="checkbox"/>
<b>Proper duct design provided?</b> (See Installation - Duct) <input type="checkbox"/>	<b>Condensate drain tested?</b> (See Installation - Isolators & Drain) <input type="checkbox"/>	<b>Start-up check lists complete?</b> (See Installation - Startup - Pre-Startup Checklists) <input type="checkbox"/>
<b>Proper ventilation provided?</b> (See Installation - Ventilation) <input type="checkbox"/>	<b>Condensate pump installed properly?</b> (See Installation - Isolators & Drain) <input type="checkbox"/>	<b>Blower rotation on 3-phase units correct?</b> (See Installation - Wiring - Power) <input type="checkbox"/>
<b>Vapor retardant installed properly?</b> (See Natatorium - Moisture Migration) <input type="checkbox"/>	<b>Pool water piping installed properly?</b> (See Installation - Piping - Pool Water) <input type="checkbox"/>	<b>Air flow and blower speed adjusted?</b> (See Installation - Air Distribution - Adjust Airflow) <input type="checkbox"/>
<b>NO chemicals in mechanical room?</b> (See Installation - Unpacking & Locating) <input type="checkbox"/>	<b>Main disconnect switch installed?</b> (See Installation - Wiring - Power) <input type="checkbox"/>	<b>Refrigerant charge OK?</b> (See chiller manual) <input type="checkbox"/>
<b>Adequate service access provided?</b> (See Installation - Unpacking & Locating) <input type="checkbox"/>	<b>Remote condenser installed properly?</b> (See condenser manual) <input type="checkbox"/>	<b>No fault codes are displayed on operator panel?</b> <input type="checkbox"/>
<b>Units level and vibration isolated?</b> (See Installation - Isolators & Drain) <input type="checkbox"/>	<b>Operator panel installed properly?</b> (See Installation - Wiring - Control Signals - Remote Display) <input type="checkbox"/>	<b>Set points are at design conditions?</b> (see unit nameplate) <input type="checkbox"/>
<b>Flexible duct installed at inlet and outlet of DRY-O-TRON®?</b> (See Installation - Duct) <input type="checkbox"/>	<b>Outdoor temperature sensor (if any) installed properly?</b> (See Installation - Field Wiring Diagram) <input type="checkbox"/>	<b>Bypass damper open if room temp &gt; 78°F?</b> <input type="checkbox"/>
	<b>Wire connections checked for</b>	<b>Air flow</b> ..... cfm .....

Optional outdoor air cooled condenser location      Above D.O.T.       Below D.O.T.       Same level as D.O.T.

Refrigerant connection size ..... Hot gas ..... Liquid .....      Pipe length from D.O.T. to condenser .....

Data subject to change without notice.

STARTUP

## Terms of Limited Warranty

### DRY-O-TRON® Energy Recycling Dehumidifiers (packaged units) and Factory Supplied Accessories

#### General

Dectron Inc. warrants as set forth and for the time periods shown below that it will furnish to the original owner, through a Dectron Inc. authorized installing contractor or service organization, a new or rebuilt part for a part which has failed because of a defect in workmanship or material. Dectron Inc. reserves the right to apply handling and inspection charges in the case of parts or equipment improperly returned as defective whether under warranty or not.

#### Registration and Start-Up Report

Warranty void unless upon start-up of the unit the "Start-Up Report and Warranty Registration" is completed and sent to the factory within one week of initial start-up. This will also register the compressor warranty with the compressor manufacturer.

#### Initial 30-Day Warranty

During the first 30 days from initial start-up and subject to prior approval from the factory, Dectron Inc. will provide and/or reimburse the approved labor, materials, and shipping costs incurred in the replacement of a defective part.

#### Remainder of 25-Month Warranty

Upon expiry of the initial 30-day warranty, and until completion of the twenty-fifth month from date of shipment from Dectron Inc., if any part supplied by Dectron Inc. fails because of a defect in workmanship or material, Dectron Inc. will furnish a new or rebuilt part F.O.B. factory. No reimbursement will be made for expenses incurred in making field adjustments or replacements unless specifically re-approved by Dectron Inc. in writing beforehand.

#### Applicability

This warranty is applicable only to products that are purchased and retained in the United States and Canada. This warranty is not applicable to:

- △ Products that have become defective or damaged as a result of the use of a contaminated water circuit or operation at abnormal water temperatures and/or flow rates.
- △ Parts that wear out due to normal usage, such as air filters, belts, fuses and refrigerant.
- △ Products that have been moved from the location where they were first installed.
- △ Any portion of the system not supplied by Dectron Inc.
- △ Products on which the model and/or serial number plates have been removed or defaced.
- △ Products on which payment is in default.
- △ Products which have become defective or damaged as a result of unauthorized opening of refrigerant circuit, improper wiring, electrical supply characteristics, poor maintenance, accidents, transportation, misuse, abuse, fire, flood, alteration and/or misapplication of the product.
- △ Products operated without clean, properly installed air filters.
- △ Products not installed, operated, and maintained as per the applicable Dectron Inc. Owner's Manual.

#### Transportation Costs

After the initial 30-day warranty period has expired, charges covering transportation of the defective part(s) to Dectron Inc. from the customer site and replacement part(s) from Dectron Inc. to the customer site are not covered by this warranty.

#### Limitations

This warranty is given in lieu of all other warranties. Anything in the warranty notwithstanding, any implied warranties of fitness for particular purpose and merchantability shall be limited to the duration of this express warranty. Manufacturer expressly disclaims and excludes any liability for consequential or incidental damage for breach of any express or implied warranty.

Where a jurisdiction does not allow limitations or exclusions in a warranty, the foregoing limitations and exclusions shall not apply to the extent of legislation, however, in such case the balance of the above warranty shall remain in full force and effect.

This warranty gives specific legal rights. Other rights may vary according to local legislation.

#### Obtaining Warranty Service

Normally, the DECTRON INC. AUTHORIZED CONTRACTOR who installed the products will provide warranty service to the owner. Should the installing contractor be unavailable, contact your local Dectron, Inc. representative or the factory.

#### Force Majeure

Dectron Inc. will not be liable for delay or failure to provide warranty service due to government restrictions or restraints, war, strikes, material shortages, acts of God or other causes beyond Dectron Inc.'s control.

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OPERATION

Air Filters

Maintenance

Operation

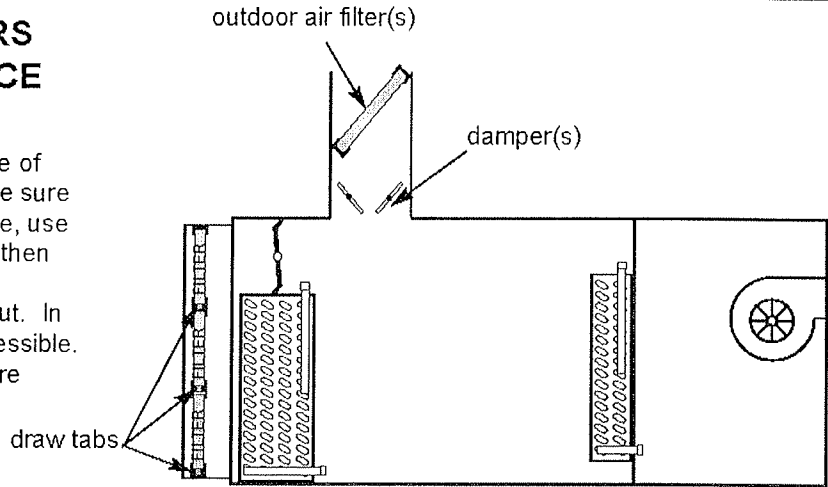
CHECK THAT ALL FILTERS ARE CLEAN AND IN PLACE

Check Air Filters

There may be several air filters, some of which may not be readily visible. To be sure that all the filters are clean and in place, use the draw tabs to remove all the filters, then re-install them.

Other units may have filters that lift out. In this case the filters will be directly accessible.

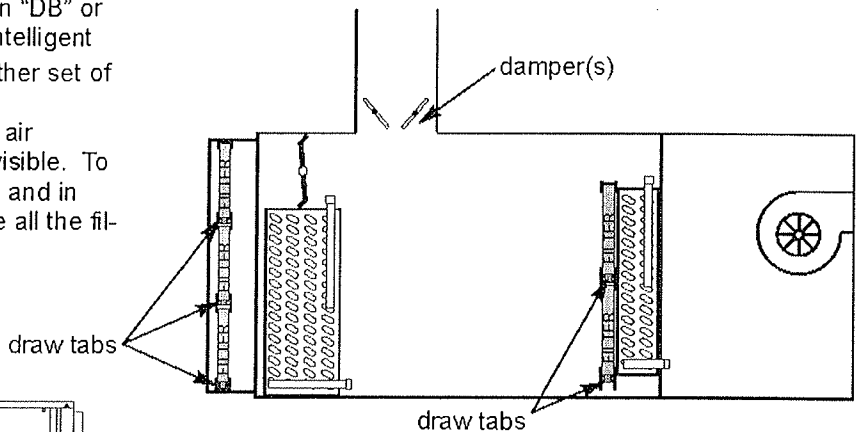
Filters for outdoor air must be moisture resistant.



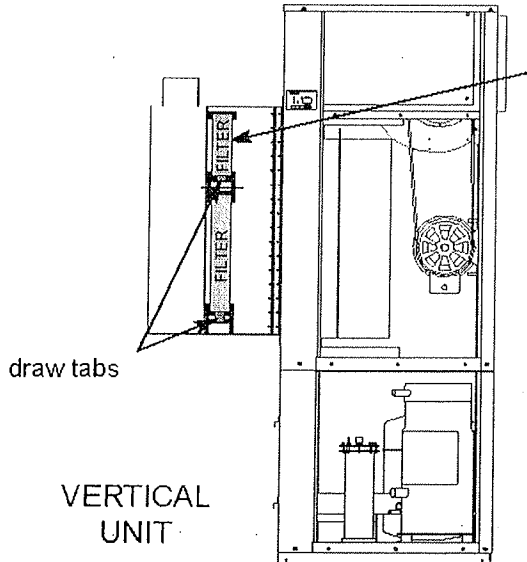
The size and number of filters and draw tabs may vary.

For units with models beginning in "DB" or "RB", which have Economizer or Intelligent Energy Saver®, there may be another set of filters before the reheat coil.

There may be several reheat coil air filters, some of which may not be visible. To be sure that all the filters are clean and in place, use the draw tabs to remove all the filters, then re-install them.



draw tabs



There may be several air filters, some of which may not be visible from the access panel. To be sure that all the filters are clean and in place, use the draw tabs to remove all the filters, then re-install them.

The size and number of filters and draw tabs may vary.

OPERATION

Blower Belts

Maintenance

Operation

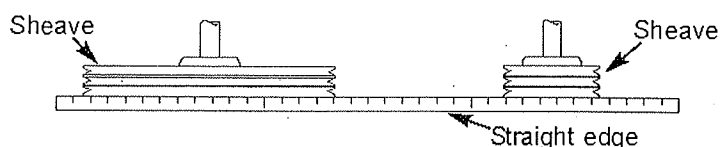
V-Belt Tensioning

Belt size	Small sheave diameter (in)	Deflection force (lbs.)		
		Initial Installation	Re-tensioning	
			Max.	Min.
A	3.0 - 3.4	3.3	2.9	2.2
	3.6 - 4.2	3.5	3.1	2.4
	4.6 - 6.0	3.7	3.3	2.5
B	4.6 - 5.4	6.0	5.1	4.0
	5.6 - 7.4	6.3	5.5	4.2
	8.6 - 9.4	6.6	5.7	4.4
C	7.0 - 8.5	13.2	11.5	8.8
	9.0 - 12.0	13.9	12.1	9.3
	13.0 - 16.0	14.6	12.6	9.7
D	12.0 - 15.5	26.5	22.9	17.6
	16.0 - 18.0	27.8	24.3	18.7
	22.0 - 27.0	29.1	25.6	19.6
E	17.7 - 23.6	39.7	34.4	26.5
	23.7 - 31.5	41.7	36.2	27.8
	31.6 - 39.3	43.7	37.9	29.1
AX	2.1 - 3.4	4.4	3.7	2.9
	3.6 - 4.2	4.6	4.0	3.1
	4.6 - 6.0	4.9	4.2	3.3
BX	3.7 - 5.4	7.7	6.6	5.1
	5.6 - 7.4	8.2	7.1	5.5
	8.6 - 9.4	8.6	7.5	5.7
CX	5.8 - 8.5	17.2	15.0	11.5
	9.0 - 12.0	18.1	15.7	12.1
	13.0 - 16.0	19.0	16.5	12.8
3V	2.65 - 3.35	5.5	4.8	3.9
	3.65 - 4.12	6.4	5.7	4.4
	4.5 - 5.6	7.5	6.6	5.1
	6.0 - 10.6	8.6	7.5	5.7
5V	7.1 - 8.5	19.2	16.7	13.0
	9.0 - 11.8	23.3	20.3	15.6
	12.5 - 16.0	27.3	23.8	18.5
8V	12.5 - 16.0	50.9	44.3	34.4
	17.0 - 20.0	57.1	49.8	38.6
	21.2 - 24.8	61.3	53.3	41.4
3VX	2.2 - 3.35	5.5	4.8	3.9
	3.65 - 4.12	6.4	5.7	4.4
	4.5 - 5.6	7.5	6.6	5.0
	6.0 - 10.6	8.6	7.5	5.7
5VX	4.4 - 8.5	19.2	16.7	13.0
	9.0 - 11.8	23.3	20.3	15.6
	12.5 - 16.0	27.3	23.8	18.5

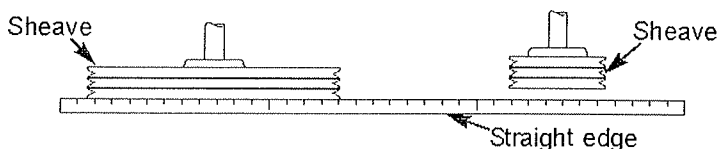
Where sheaves carry more than one belt, never replace only one belt. If any belt must be replaced, replace all the belts with new ones. When replacing multiple belts use only new belts from the same manufacturer and the same lot number, or use matched belts. Failure to do this will result in severe belt wear.

When removing or replacing belts, always relieve the belt tension to position the belts. Never prize the belts with a screwdriver or other tool.

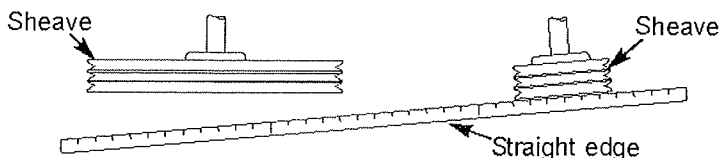
Belt sheaves must be properly aligned, as shown below.



While the sheaves were aligned at the factory, future adjustments may cause varying degrees of misalignment. A common problem is parallel misalignment, as shown below. Parallel misalignment causes excessive belt, sheave, and bearing wear.



Another common problem is angular misalignment, as shown below. Angular misalignment causes excessive belt, sheave, and bearing wear.

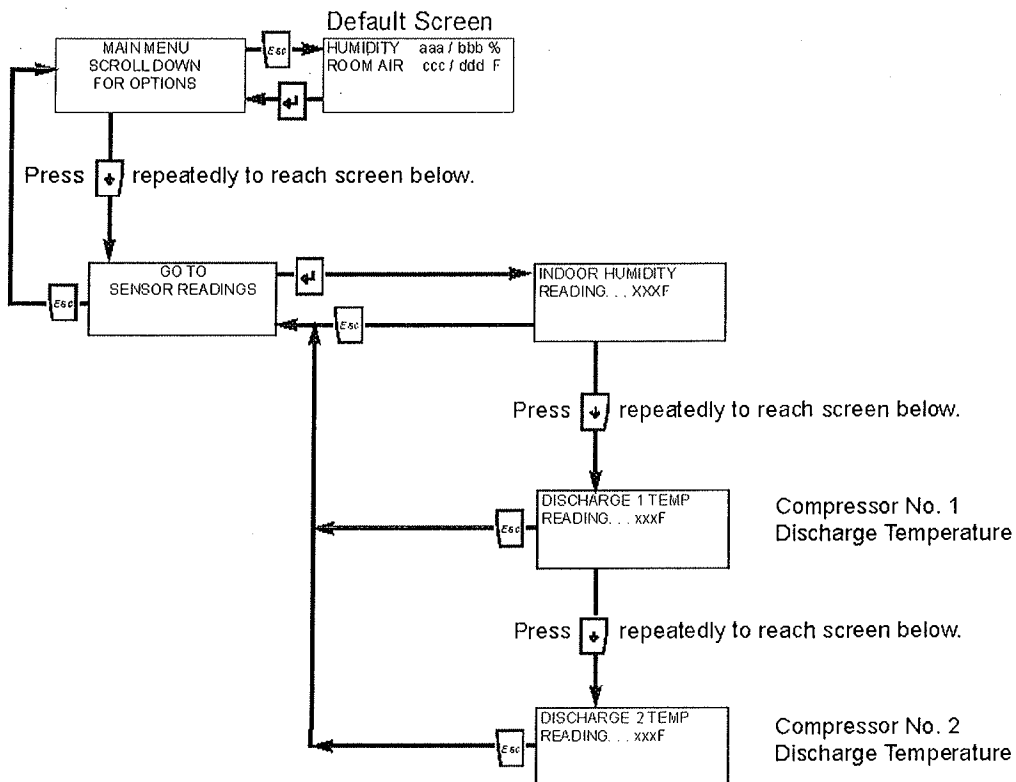


OPERATION

Check Discharge Temps. Maintenance

Operation

1. Choose a time when the room air temperature, room relative humidity, and pool water temperature are near the nameplate values, so that the unit will operate at normal capacity. (See **Product Description - Unit Nameplate**).
2. Start the unit per the instructions given in **Startup - Enable Operation**. Operate the unit in dehumidification.
3. Be sure that the refrigerant sight glass is completely full of liquid, with no bubbles. If bubbles are present, return to **Installation**.
4. After the compressor(s) has been running for at least 20 minutes, the compressor discharge temperature(s) as measured by the Supervisaire® controller (see **Operation - User Interface Map**) should be between 180°F (82°C) and 200°F (93°C). If not, see **Start-up - TXV Adjustment**.



OPERATION

Operation

Logical Flowchart

Air Conditioning

Δ Dehumidification

On a call for dehumidification only, DRY-O-TRON® operates in dehumidification with minimum water-heating mode.

Δ On a call for cooling

The A/C hot gas solenoid valve is energized and the outdoor condenser fan is operating. The DRY-O-TRON® runs in air-conditioning mode.





Δ Pool Water Heating

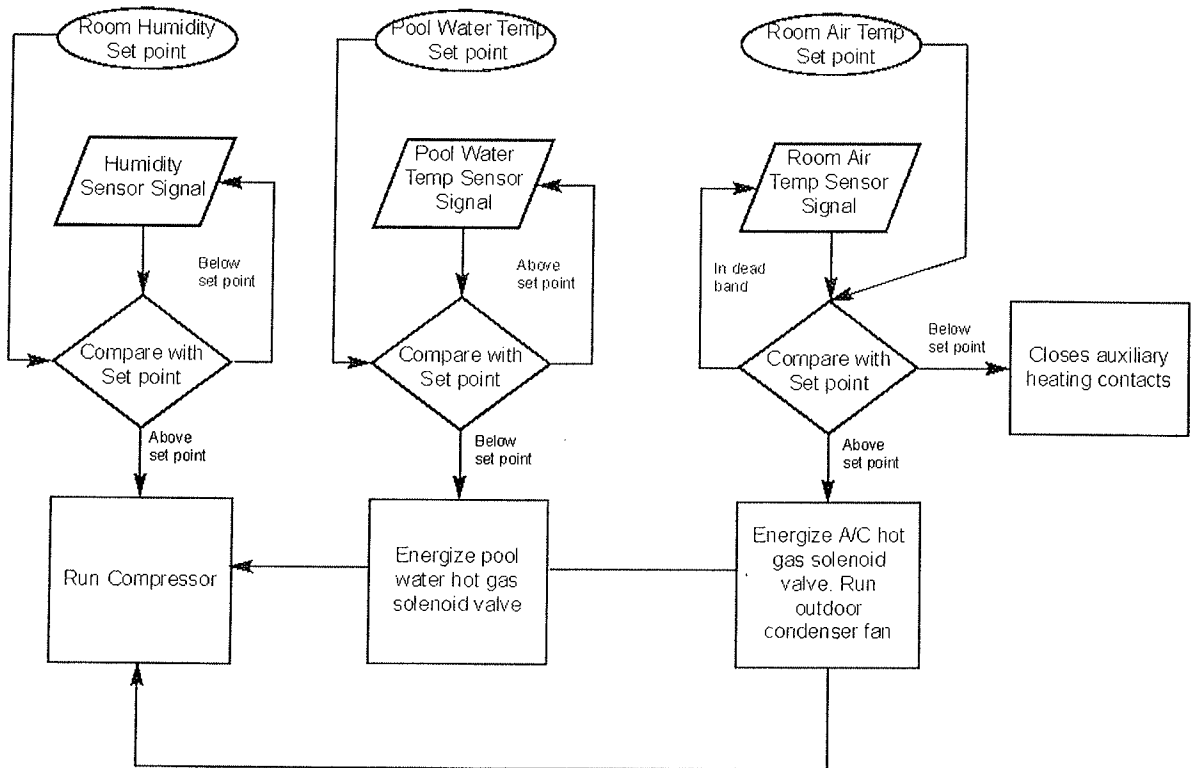
Pool water temperature is maintained by minimum and maximum water heating modes. On a call for pool water heating, the pool water hot gas solenoid valve is energized. The DRY-O-TRON® operates in maximum water-heating mode.

Δ Space Heating

On a call for space heating, the DRY-O-TRON® operates as above for dehumidification and pool-water heating. In addition, the auxiliary space heating system is activated by contacts provided.

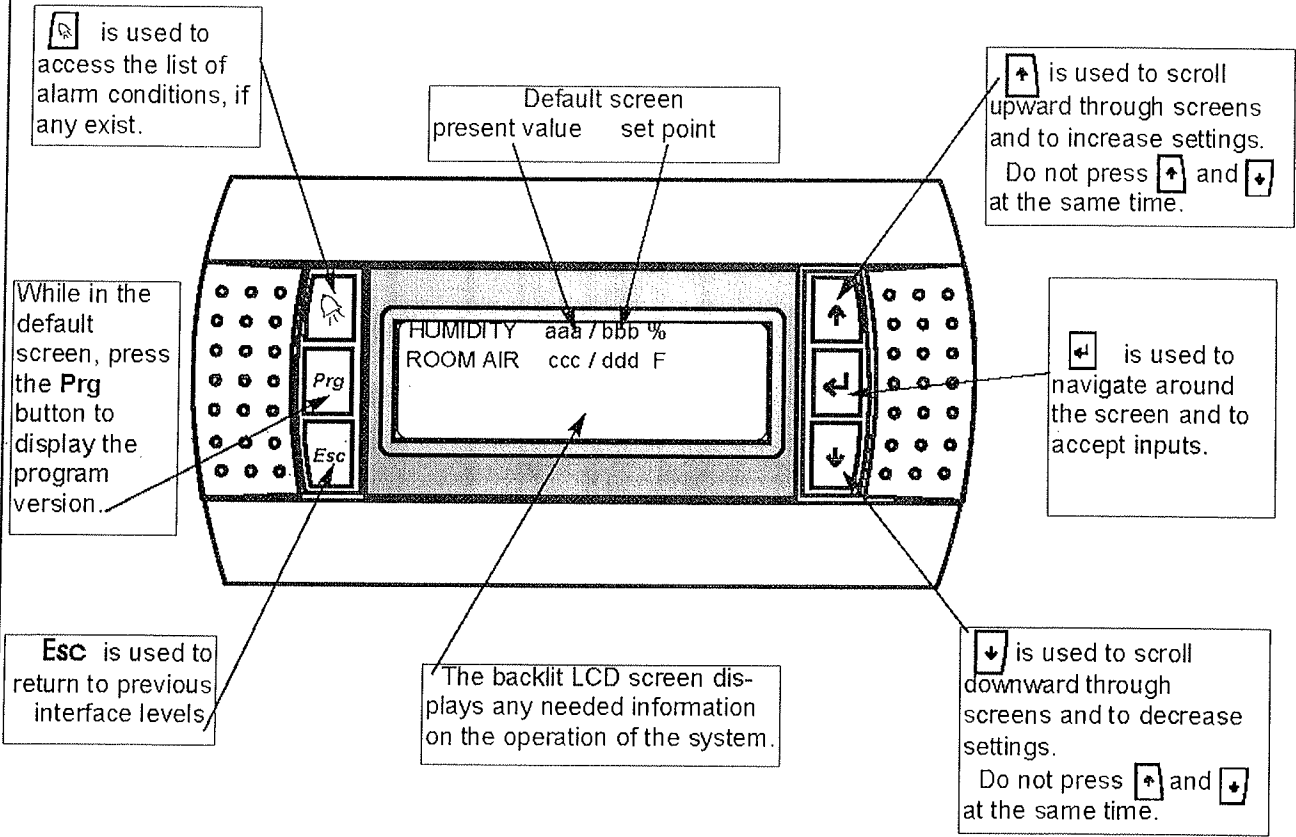
Symbols

-  internal storage register
-  general input / output
-  conditional branch
-  process

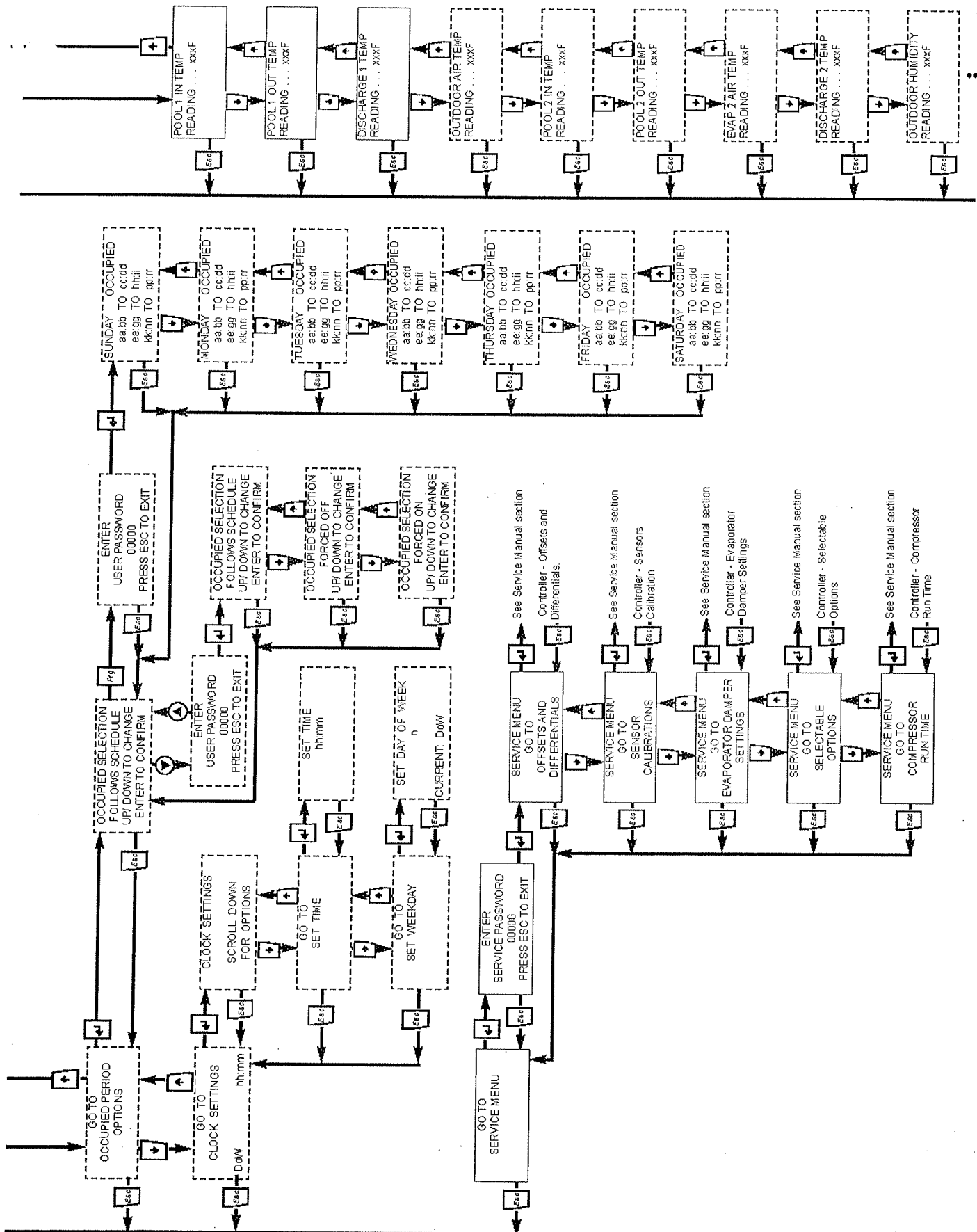


OPERATION





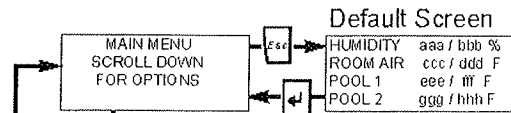
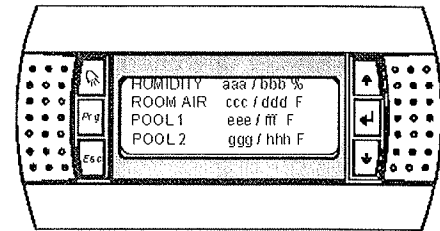
OPERATION



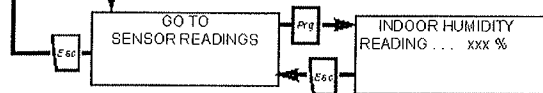
Read Sensors

Operation

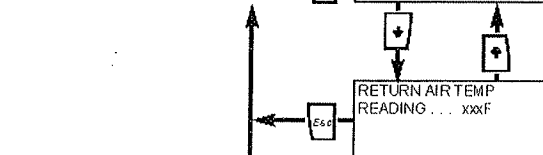
The values of some sensor signals are displayed on the default screen, as at right. To read all sensors, follow the steps below:



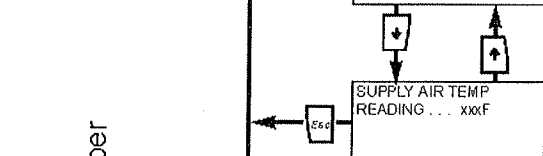
Press repeatedly to reach screen below.



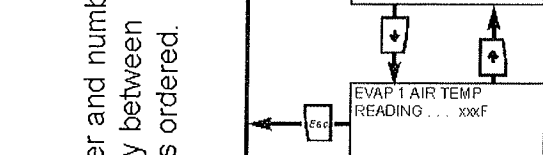
This screen displays the relative humidity of the room air, as measured at the return duct



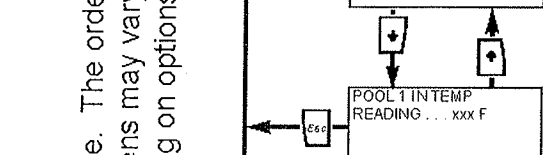
This screen displays the temperature of the room air, as measured at the return duct



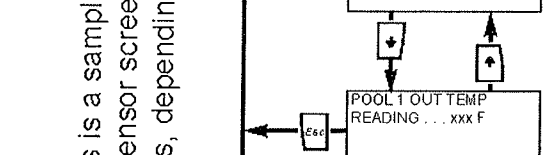
This screen displays the temperature of the supply air, as measured at the DRY-O-TRON® supply blower.



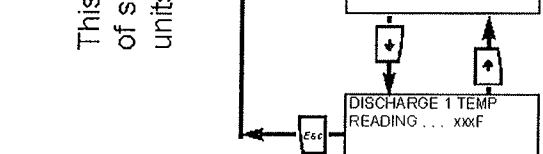
This screen displays the temperature of the air leaving the evaporator of the first refrigeration circuit.



This screen displays the temperature of the pool #1 water entering the DRY-O-TRON®.



This screen displays the temperature of the pool #1 water leaving the DRY-O-TRON®.



This screen displays the temperature of the hot refrigerant gas leaving the #1 compressor. This is important to a proper startup. See **Startup - TXV Adjustment**.

This is a sample. The order and number of sensor screens may vary between units, depending on options ordered.


⋮  
to other readings

OPERATION

Supervisaire® Controller Messages

Operation

STATUS MESSAGES  
SCROLL DOWN  
TO VIEW

Press  repeatedly to view any of the following Status messages that apply at the moment.

- A/C ON - The Air-Conditioning feature is operating.
- AIR HEATING CALL - The temperature of the room is below set point minus offset minus differential.
- ASCT 1 ON - The minimum OFF time for compressor 1 has not elapsed.
- ASCT 2 ON - The minimum OFF time for compressor 2 has not elapsed.
- AUX. AIR HEATING ON STAGE 1 - First stage auxiliary air heating is ON.
- AUX. AIR HEATING ON STAGE 2 - Second stage auxiliary air heating is ON.
- AUX. AIR HEATING ON STAGE 3 - Third stage auxiliary air heating is ON.
- AUX. AIR HEATING ON STAGE 4 - Fourth stage auxiliary air heating is ON.
- BLOWER ON - Blower is operating.
- BLOWER REMOTE SWITCH OFF - The blower is turned off by remote manual input.
- BLOWER TURNED OFF - See **Startup - Enable Operation**.
- COMPRESSOR 1 EMERGENCY SWITCH OFF - The manual ON/OFF switch is OFF.
- COMPRESSOR 1 PUMPDOWN - Compressor 1 is preparing to shut down.
- COMPRESSOR 2 PUMPDOWN - Compressor 2 is preparing to shut down.
- COMPRESSOR 1 TURNED OFF - See **Startup - Enable Operation**.
- COMPRESSOR 2 EMERGENCY SWITCH OFF - The manual ON/OFF switch is OFF.
- COMPRESSOR 2 TURNED OFF - See **Startup - Enable Operation**.
- COOLING CALL - The temperature of the room is above set point plus offset plus differential.
- DEHUMIDIFICATION CALL - The relative humidity of the room is above set point plus differential.
- DEHUMIDIFICATION ON - One or more compressors are operating.
- EVAPORATOR DAMPER CLOSED - The evaporator bypass damper is closed to divert air to the evaporator.
- ECONOMIZER ON - The Economizer feature is operating.
- GAS BOILER ON - The gas boiler on units so equipped is operating.
- INTELLIGENT ENERGY SAVER ON - The Intelligent Energy Saver feature is operating.
- LEAD LAG ON - Compressor 2 is first stage.
- MANUAL RESET REQUIRED - A fatal alarm has occurred. See **Operation - Start, Stop, Reset**.
- MAXIMUM EXHAUST BLOWER ON - The maximum amount of room air is being exhausted.
- MINIMUM EXHAUST BLOWER ON - The standby amount of room air is being exhausted.
- OCCUPIED PERIOD - Time-of-day is defined as that in which people are usually present.
- OIL RETURN MODE 1 ON - Refrigerant is being diverted through the outdoor condenser for oil return.
- OIL RETURN MODE 2 ON - Refrigerant is being diverted through the outdoor condenser for oil return.
- PLEASE WAIT... Compressor 1 will auto reset - A possibly fatal alarm is being analyzed.
- PLEASE WAIT... Compressor 2 will auto reset - A possibly fatal alarm is being analyzed.
- POOL 1 AUX ON - An auxiliary heater is heating pool 1 water.
- POOL 2 AUX ON - An auxiliary heater is heating pool 2 water.
- POOL 1 HEATING CALL - The temperature of pool 1 water is below set point minus differential.
- POOL 2 HEATING CALL - The temperature of pool 1 water is below set point minus differential.
- POOL 1 HEATING ON - Water from pool 1 is being heated.
- POOL 2 HEATING ON - Water from pool 2 is being heated.
- PURGE MODE ON - Room air is being exhausted to dilute superchlorination gases.
- VENTILATION ON - Cooling or dehumidification by ventilation is enabled in the event of compressor failure or no air-conditioning option.
- ZERO REHEAT ON - Supply air temperature is limited to the return air temperature.

OPERATION

# Owner's Manual DS/DSV/RS/DB/RB Series Dehumidifier

## Supervisaire<sup>®</sup> Controller Diagnostics

## Operation

ALARM	POSSIBLE CAUSES	CHECKS & CORRECTIONS
<p>COMPRESSOR 1 HIGH PRESSURE FAULT or COMPRESSOR 2 HIGH PRESSURE FAULT</p>	<p>Manual isolation valves not opened at installation</p> <p>Loss of cooling water on water-cooled units</p> <p>Loss of air flow in remote condensers on air-cooled units</p> <p>Improperly adjusted pressure control valve(s)</p> <p>Return air temperature too high</p> <p>Fouled or damaged reheat coil</p> <p>Excess refrigerant</p> <p>Defective high pressure switch</p>	<ul style="list-style-type: none"> <li>• Be sure all isolation valves are opened.</li> <li>• Be sure water flow is correct. See Startup - Adjust Flow Switches.</li> <li>• Be sure the cooling water temperature is not above that stated on the unit nameplate.</li> <li>• Be sure the remote condenser safety switch is ON. Be sure that all fuses (if any) are good.</li> <li>• For polyphase condensers, be sure that all phases are present. Be sure the fans turn the proper direction.</li> <li>• Be sure that there are no walls, fences, bushes, or other air flow interruptions near the remote condenser. See Installation - Locate Remote Condenser.</li> <li>• Be sure the remote condenser is clean.</li> <li>• Consult Dectron or a Dectron-certified technician.</li> <li>• Be sure set points correspond to those shown on the unit nameplate.</li> <li>• Be sure controller outputs are not calling for heating. See unit wiring diagram.</li> <li>• Be sure reheat coil is not coated with foreign materials such as dirt from unfiltered outdoor air or scum from spas / hot tubs.</li> <li>• Be sure reheat coil is not corroded. Corrosion is due to poor chemical storage or excessive chloramine production.</li> <li>• This will be most common in warm weather. Be sure the total refrigerant charge corresponds to the amount shown on the unit nameplate.</li> <li>• Consult Dectron or a Dectron-certified technician.</li> </ul>

OPERATION

# Owner's Manual DS/DSV/RS/DB/RB Series Dehumidifier

## Supervisaire® Controller Diagnostics

## Operation

ALARM	POSSIBLE CAUSES	CHECKS & CORRECTIONS
<p>COMPRESSOR 1 OIL FAILURE or COMPRESSOR 2 OIL FAILURE</p>	<p>Low oil level in compressor crankcase</p> <p>Excessive compressor wear</p> <p>Compressor oil pump failure</p> <p>Compressor oil pressure switch failure</p>	<ul style="list-style-type: none"> <li>• Check oil level in compressor oil sight glass.</li> <li>• Be sure the evaporator pressure does not operate below 50 PSI for significant periods.</li> <li>• For units with air-cooled air conditioning, be sure the refrigerant tubes to the remote condenser are not longer than the length specified on the unit nameplate.</li> <li>• For units with air-cooled air conditioning, be sure the refrigerant tubes to the remote condenser are the same O.D. as specified on the unit nameplate.</li> <li>• For units with air-cooled air conditioning where the remote condenser is more than 20 feet above the DRY-O-TRON®, be sure the hot-gas riser tube(s) have P-traps as specified in this manual.</li> <li>• Consult Dectron or a Dectron-certified technician.</li> <li>• Consult Dectron or a Dectron-certified technician.</li> <li>• Oil pressure should be more than 10 PSI above evaporator pressure.</li> <li>• Consult Dectron or a Dectron-certified technician.</li> </ul>
<p>COMPRESSOR 1 OVERHEAT or COMPRESSOR 2 OVERHEAT</p>	<p>Applied voltage out of tolerance or out of balance</p> <p>Low oil level in compressor crankcase</p> <p>Evaporator pressure too low or hot gas bypass valve open too long (when so equipped).</p> <p>Defective refrigerant expansion valve</p> <p>Defective compressor overheat detector</p>	<ul style="list-style-type: none"> <li>• A qualified person should be sure that the average applied voltage is within <math>\pm 10\%</math> of the nameplate value and that the individual phase voltages are within <math>\pm 1\%</math> of the average voltage (See NEMA MG-1).</li> <li>• See "OIL PRESSURE FAILURE" above</li> <li>• Be sure the evaporator pressure does not operate below 55 PSI for significant periods. Be sure HGBV is properly adjusted.</li> <li>• Consult Dectron or a Dectron-certified technician.</li> <li>• Consult Dectron or a Dectron-certified technician.</li> </ul>

OPERATION

ALARM	POSSIBLE CAUSES	CHECKS & CORRECTIONS
<p>COOLING PERFORMANCE ALARM</p>	<p>A minimum temperature difference across the evaporator has not been produced after five minutes of refrigeration.</p>	<ul style="list-style-type: none"> <li>• Be sure the associated refrigerant sight glass is full. No droplets should be visible on the inside of the sight glass. No bubbles should be visible in the sight glass after five minutes of operation.</li> <li>• Be sure the return air flow rate is as specified.</li> <li>• Be sure all manual isolation valves are fully open.</li> <li>• Be sure the refrigerant filter-drier is not clogged.</li> <li>• Be sure the refrigerant expansion valve is properly adjusted.</li> <li>• Be sure the pressure control valves have not been adjusted. Contact Dectron or a Dectron-certified technician.</li> </ul>
<p>DISCHARGE 1 SENSOR FAULT or DISCHARGE 2 SENSOR FAULT</p>	<p>The signal from the compressor discharge temperature sensor is out of range.</p>	<ul style="list-style-type: none"> <li>• Be sure the sensor cable is properly connected to both the sensor and the controller.</li> <li>• Disconnect the cable from the controller and check the resistance of the sensor and cable combination. Compare to the chart at the end of this section. If the resistance is outside the allowable range, disconnect the cable from the sensor and be sure the resistance of the cable is above 1 million ohms. Connect the ends of the cable wires together and be sure the cable resistance is less than 5 ohms. If either condition fails, replace cable. Compare the resistance of the sensor itself to the sensor resistance chart. Replace sensor if necessary. Connect sensor and cable to controller.</li> </ul>
<p>DIRTY FILTERS</p>	<p>The signal from the filter differential pressure sensor indicates dirty filters. Defective sensor or wires.</p>	<ul style="list-style-type: none"> <li>• Install clean filters.</li> <li>• Check for continuity.</li> </ul>

OPERATION

**Owner's Manual DS/DSV/RS/DB/RB Series Dehumidifier**

**Supervisaire<sup>®</sup> Controller Diagnostics**

**Operation**

ALARM	POSSIBLE CAUSES	CHECKS & CORRECTIONS
<p><b>GAS BOILER ALARM</b></p>	<p>A general failure of an associated gas boiler supplied by Dectron.</p>	<ul style="list-style-type: none"> <li>• Consult the boiler manual.</li> </ul>
<p><b>GLYCOL PUMP OVERLOAD</b>                      The motor protection device for the glycol pump (where so equipped) has tripped.</p>	<p>Excessive glycol viscosity</p> <p>Glycol temperature colder than expected.</p> <p>Applied voltage out of tolerance or out of balance</p>	<ul style="list-style-type: none"> <li>• Be sure the glycol is of the proper type and concentration.</li> <li>• Be sure glycol temperature is above -30°F.</li> <li>• A qualified person should be sure that the average applied voltage is within <math>\pm 10\%</math> of the nameplate value and that the individual phase voltages are within <math>\pm 1\%</math> of the average voltage (See NEMA MG-1). Reset overload.</li> </ul>
<p><b>OUTDOOR HUMIDITY SENSOR FAULT</b></p> <p>Humidity sensor signal is out of range.</p>	<p>Sensor cable disconnected</p> <p>Sensor cable broken or shorted</p> <p>Defective sensor</p>	<ul style="list-style-type: none"> <li>• Be sure the sensor cable is properly connected to both the sensor and the controller.</li> <li>• Disconnect the cable from the sensor and from the controller and be sure the resistance of the cable is above 1 million ohms. Connect the ends of the cable wires together at the sensor end and be sure the cable resistance is less than 5 ohms. If either condition fails, replace the cable.</li> <li>Compare the output signal of the sensor itself to the expected value. Replace sensor if necessary. Connect sensor and cable to controller.</li> </ul>
<p><b>MAX. EXHAUST BLOWER OVERLOAD</b>                      (Purge mode equipped units)                      The motor protection device for the larger exhaust air blower has tripped.</p>	<p>Excess Maximum Exhaust air flow rate</p> <p>Applied voltage out of tolerance or out of balance</p>	<ul style="list-style-type: none"> <li>• Be sure the Maximum Exhaust air flow rate is as specified. Excess air flow can overload some blowers.</li> <li>• A qualified person should be sure that the average applied voltage is within <math>\pm 10\%</math> of the nameplate value and that the individual phase voltages are within <math>\pm 1\%</math> of the average voltage (See NEMA MG-1). Reset overload.</li> </ul>

OPERATION



# Owner's Manual DS/DSV/RS/DB/RB Series Dehumidifier

## Supervisaire<sup>®</sup> Controller Diagnostics

## Operation

ALARM	POSSIBLE CAUSES	CHECKS & CORRECTIONS
<p>POOL 1 IN SENSOR FAULT or POOL 2 IN SENSOR FAULT</p> <p>The signal from the inlet pool water temperature sensor is out of range.</p>	<p>Sensor cable disconnected</p> <p>Sensor cable broken or shorted</p> <p>Defective sensor</p>	<ul style="list-style-type: none"> <li>• Be sure the sensor cable is properly connected to both the sensor and the controller.</li> <li>• Disconnect the cable from the controller and check the resistance of the sensor and cable combination. Compare to the chart at the end of this section. If the resistance is outside the allowable range, disconnect the cable from the sensor and be sure the resistance of the cable is above 1 million ohms. Connect the ends of the cable wires together and be sure the cable resistance is less than 5 ohms. If either condition fails, replace cable.</li> <li>• Compare the resistance of the sensor itself to the sensor resistance chart. Replace sensor if necessary. Connect sensor and cable to controller.</li> </ul>
<p>POOL 1 IN SENSOR FAULT or POOL 2 IN SENSOR FAULT</p> <p>The signal from the inlet pool water temperature sensor is out of range.</p>	<p>Sensor cable disconnected</p> <p>Sensor cable broken or shorted</p> <p>Defective sensor</p>	<ul style="list-style-type: none"> <li>• Be sure the sensor cable is properly connected to both the sensor and the controller.</li> <li>• Disconnect the cable from the controller and check the resistance of the sensor and cable combination. Compare to the chart at the end of this section. If the resistance is outside the allowable range, disconnect the cable from the sensor and be sure the resistance of the cable is above 1 million ohms. Connect the ends of the cable wires together and be sure the cable resistance is less than 5 ohms. If either condition fails, replace cable.</li> <li>• Compare the resistance of the sensor itself to the sensor resistance chart. Replace sensor if necessary. Connect sensor and cable to controller.</li> </ul>

OPERATION



Supervisaire<sup>®</sup> Controller Diagnostics

Operation

ALARM	POSSIBLE CAUSES	CHECKS & CORRECTIONS
<p><b>WALL SENSOR FAULT</b></p> <p>The signal from the wall temperature sensor (where so equipped) is out of range.</p>	<p>Sensor cable disconnected</p> <p>Sensor cable broken or shorted</p> <p>Defective sensor</p>	<ul style="list-style-type: none"> <li>• Be sure the sensor cable is properly connected to both the sensor and the controller.</li> <li>• Disconnect the cable from the controller and check the resistance of the sensor and cable combination. Compare to the chart at the end of this section.                             <p>If the resistance is outside the allowable range, disconnect the cable from the sensor and be sure the resistance of the cable is above 1 million ohms. Connect the ends of the cable wires together and be sure the cable resistance is less than 5 ohms. If either condition fails, replace cable.</p> </li> <li>• Compare the resistance of the sensor itself to the sensor resistance chart. Replace sensor if necessary.                             <p>Connect sensor and cable to controller.</p> </li> </ul>

OPERATION

# Appendix B Project Narrative

## **Appendix B – Scope of Work**

### **Background**

The Student Recreation Center at the University of Missouri – Columbia was originally constructed in 1929 with the addition of Brewer Fieldhouse to the Rothwell Gymnasium. Since then, the facility has been repeatedly renovated and has received a number of additions. The latest major expansion in 2003 provided two primary natatorium rooms: the competition pool room (housing both the 50 meter pool and the diving well) and Tiger Grotto.

These two natatorium rooms are each served by pool dehumidification/air handling units (PAUs), located in the east and west mechanical rooms on the third floor that flank the competition pool room. Specifically, Tiger Grotto is served by PAU-1, located in the east mechanical room, and the competition pool room is served by PAU-2 & 3 (east mechanical room), as well as PAU-4 & 5 (west mechanical room).

These Dectron PAUs have been in service since the 2003 renovation and are experiencing end-of-life failures, perhaps the most noteworthy of which are the leaks from the refrigerant circuits in each of the units, frequently leading to complete evacuation of the circuit.

### **Scope Summary**

While not exclusive to these areas, this scope in this project primarily focuses on three areas: the east penthouse mechanical room, the east rooftop, and the basement mechanical room. A very high level summary of the scope in each area is as follows:

- East mechanical room: Replacement of PAU-1, 2 & 3
- East rooftop: Addition of new OA intake and relief plenums, as well as new exhaust/relief fans. A new structural platform is being added to support this equipment.
- Basement mechanical room: Replacement of the building heating water heat exchangers (2) and pumps (2). Also, potential replacement of heating water piping to pool heat exchanger HX-3 (Alternate #1).

With a few limited exceptions, architectural, structural, electrical, plumbing, and fire protection scopes included within the project are support for the HVAC work included.

### **Construction Phasing & Shutdowns**

Because of the degree to which the systems serving the competition pool room are being affected, as well as the critical nature of the events hosted in the competition pool room, close coordination will be required between the Contractor and Owner throughout the project. As part of this coordination, there are a number of restrictions that will affect how the Contractor must approach the project.

The first notable construction restriction is the quantity of functional PAUs. Because of the need for air churn within the competition pool room, and potentially the thermal loads present as well, at least three of the four PAUs must be operational at all times. This means that construction on PAU-2 & 3 must occur sequentially, instead of simultaneously. This includes not only construction on the PAUs themselves, but the associated piping, air intakes, and air exhausts as well. In short, no work on PAU-3 may begin until the work in PAU-2 is completed and the renovated system is fully operational, programmed, tested to the owner's satisfaction, and balanced. Because this sequential method is inherently less efficient for the Contractor, all additional manpower costs must be included in the Contractor's bid.

It should be noted that, because there is only a single PAU serving Tiger Grotto (PAU-1), the owner is aware that extended downtime of that area will be unavoidable. While there are no competitive swimming events hosted in Tiger Grotto, the owner still requires that the downtime of this area be limited to less than 8 weeks. The Contractor will need to include all costs associated with drain-down and refills of the pools within Tiger Grotto within their bids. Also, because of where PAU-1 is located within the mechanical room, it is strongly recommended that this unit be replaced at the same time PAU-2 is being replaced.

The second restriction that will affect the construction is the occupancy of the competition pool room. While three operating PAUs will be sufficient to manage small-to-moderate events during shoulder seasons, there are a few known large annual events that occur which require all four PAUs to be operational simultaneously, particularly during the warmer months. While some of these events are known for 2024, many will not be known until after the contract is awarded. Consequently, close coordination with the owner will be required ahead of the PAUs arriving on site. Moreover, the owner retains the right to delay the construction on one or more of the PAUs as competitive pool events are established. Dates of the known events and likely, though unverified, events for the construction window are listed below:

Event	Start Date	Duration
Mizzou Qualifier	March 12, 2024	5 days
CSC meet	April 19, 2024	2 days
Special Olympics	June 1, 2024	1 day
CSC meet	June 14, 2024	3 days
CSC meet	July 9, 2024	5 days
Show-Me State Games	July 19, 2024	3 days*
Show-Me State Games	July 26, 2024	3 days*
Mizzou meet	September 2024	1 day
CPS meet	September 2024	2 days
Mizzou meet	October 2024	2 days
CSC meet	October 2024	3 days
Mizzou meet	November 2024	3 days

\*There are no swimming events during the Show-Me State Games; however, there are still events in the building that the contractor will need to coordinate around.

The third restriction is regarding the system shutdowns. As inferred in the *Scope Summary* section above, there will be some selective shutdowns required within this project. These shutdowns include:

- Temporary loss of heating water to the building
  - Occurs during the building heat exchanger and heating water pump replacement in the basement mechanical room.
  - One of the new chilled water pumps needs to be set and aligned (but not piped in) prior to demolition of the existing pump to minimize the downtime.
  - Heating water system downtime will be limited to 16 consecutive hours on the same day, which will be for pulling old piping at the pump and connecting the first new pump into the system. Also includes the valving for the second new heating water pump, so that it can be installed later without requiring a second system outage.
  - The outage duration noted above is from the moment the system becomes unavailable to the moment it becomes fully operational again. Therefore, the limited draining and refill that will be required needs to fit within this window as well.
  - The second existing heating water pump will be demolished and second new heating water pump installed after the heating water service to the building is resumed.
  - Day for the heating water outage will be scheduled at pre-construction meeting with owner but will need to occur as soon as possible in construction. Because of the current lead times of pumps (14-16 weeks), any delay will push the pump replacement too far

into colder weather. The contractor is responsible for expedient submittal creation to avoid this situation.

- Temporary loss of heating and chilled water to the east mechanical room
  - Occurs when the PAU piping connections to the room mains are replaced. This downtime will primarily occur during the PAU-3 replacement. PAU-1 & 2 are also having their connections to the room mains replaced; however, these are further downstream than PAU-3. Consequently, these sections of piping can be isolated while PAU-3 remains operational.
  - Common piping being replaced is relatively limited; outage should not last more than 8 consecutive hours on the same day, including draining and refilling. During this time, PAU-1, 2 & 3 will all be without heating or chilled water.
- Temporary loss of dive pool heating
  - In Alternate #1, the heating water piping to the existing heat exchanger HX-3 is replaced with new. For the entirety of this piping replacement, the dive pool will not have any heating capability.
  - Additionally, as part of this piping replacement new taps off the heating water main are provided for the dive pool heat exchanger. During this tie-in, anything that is served by the east heating water main will lost heating capacity.
  - Downtime for the dive pool heating will be limited to 24 hours. Downtime for the east heating water main is 8 hours, occurring somewhere within the 24-hour downtime window for the dive pool heating.
  - As with the other outages, these durations also include draining/filling.

For all outages, the Owner will be final determiner for outage day, and reserves the right to push the outage if unseasonably warm or cold weather is expected on the planned day.

# Appendix C

## Structural Calculations

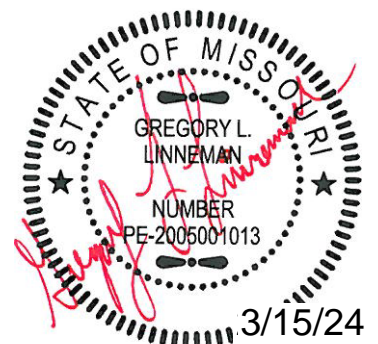


# STRUCTURAL CALCULATIONS

FOR

## CP242271 Student Rec AHU 1-3 Replacements Columbia, Missouri

Date:  
March 15, 2024



GREGORY L. LINNEMAN - PE  
MO LICENSE - 2005001013

PREPARED BY:

**CROCKETT**

ENGINEERING CONSULTANTS

1000 W Nifong Boulevard, Bldg 1 • Columbia, Missouri 65203

## DESIGN DATA

2021 INTERNATIONAL BUILDING CODE / ASCE 7-16

<u>BUILDING OCCUPANCY CATEGORY</u>	III
 <u>ROOF LOAD DATA</u>	
LIVE LOAD	20
MECHANICAL ALLOWANCE PLUS CEILING	10
DECKING AND ROOFING	10
ROOF STRUCTURE	5
TOTAL TO STRUCTURE	45 lbs/sq ft

<u>ROOF MECHANICAL PLATFORM</u>	
LIVE LOAD/EQUIPMENT WEIGHT	50
DECKING AND ROOFING	10
ROOF STRUCTURE	10
TOTAL TO STRUCTURE	70 lbs/sq ft

<u>RAIN LOADING</u>	
15 MINUTE RAIN INTENSITY	7.32 in/hr
60 MINUTE RAIN INTENSITY	3.53 in/hr

<u>ROOF SNOW LOAD DATA*</u>	(*UNBALANCED & DRIFTING SNOW TO BE DETERMINED IN ADDITION TO UNIFORM LOAD, WHERE APPLICABLE)	
$p_g =$		20 lbs/sq ft
$C_e =$		1.0
$I_s =$		1.1
$C_f =$		1.0
$p_f =$		15.40 lbs/sq ft

<u>MECHANICAL FLOOR LOAD DATA</u>	
LIVE LOAD	100
FLOOR SLAB/BEAMS	120
MECHANICAL ALLOWANCE PLUS CEILING	25.0
FLOORING	5.0
TOTAL TO STRUCTURE	250 lbs/sq ft

<u>WIND DESIGN DATA</u>	
$V_{50} =$	116 M.P.H. (3-SECOND GUST)
RISK CATEGORY	III
EXPOSURE	B
INTERNAL PRESSURE COEFFICIENT =	± 0.18
DIRECTIONAL PROCEDURE (M/WFRS - ASCE 7-10, CH 27; C&C - ASCE 7-10, CH 30, PART 4)	
MAXIMUM COMPONENTS & CLADDING WIND	+/-32.2 lbs/sq ft

<u>EARTHQUAKE DESIGN DATA</u>	
RISK CATEGORY	III
$I_E =$	1.25
$S_S =$	0.161
$S_I =$	0.094
SITE CLASS	D (ASSUMED)
$S_{DS} =$	0.172
$S_{D1} =$	0.15
SEISMIC DESIGN CATEGORY	C
BASIC SEISMIC-FORCE-RESISTING SYSTEM =	
SPECIAL REINFORCED CONCRETE SHEAR WALLS BUILDING/ ORDINARY STEEL CONCENTRICALLY BRACED FRAME MECH PLATFORM	
$R =$	6.0/3.25
$\Omega_o =$	2.5/2.0
$C_d =$	5.0/5.0

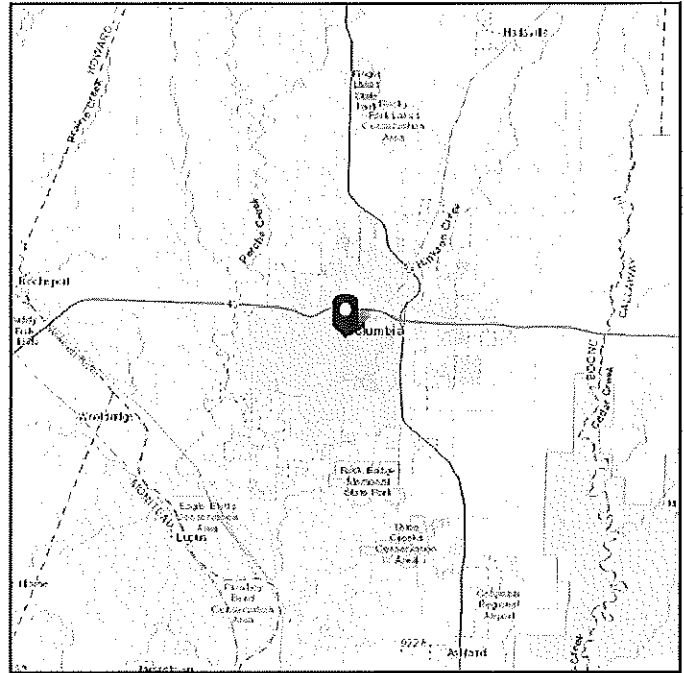
DESIGN BASE SHEAR            0.029W BUILDING/0.054W MECH PLATFORM  
EQUIVALENT LATERAL FORCE PROCEDURE

# ASCE 7 Hazards Report

**Address:**  
Columbia  
Missouri,

**Standard:** ASCE/SEI 7-16  
**Risk Category:** III  
**Soil Class:** D - Default (see Section 11.4.3)

**Latitude:** 38.95252  
**Longitude:** -92.33415  
**Elevation:** 705.1890641441333 ft (NAVD 88)



## Wind

### Results:

Wind Speed	116 Vmph
10-year MRI	75 Vmph
25-year MRI	81 Vmph
50-year MRI	88 Vmph
100-year MRI	94 Vmph

Data Source: ASCE/SEI 7-16, Fig. 26.5-1C and Figs. CC.2-1–CC.2-4, and Section 26.5.2  
Date Accessed: Fri Sep 08 2023

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-16 Standard. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (annual exceedance probability = 0.000588, MRI = 1,700 years).

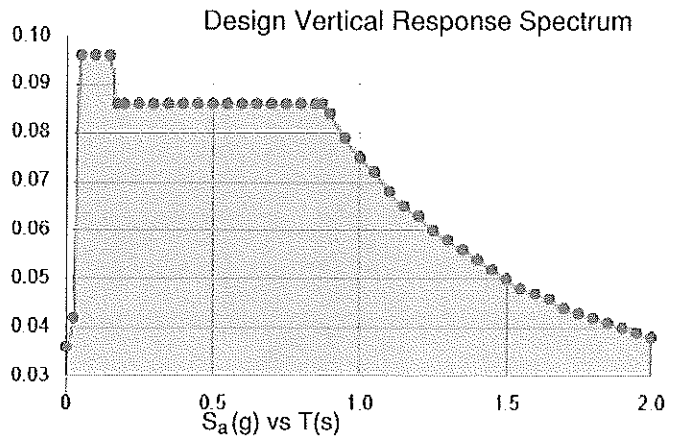
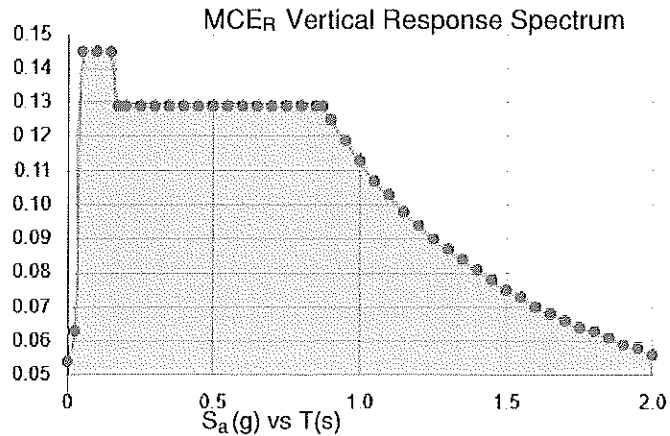
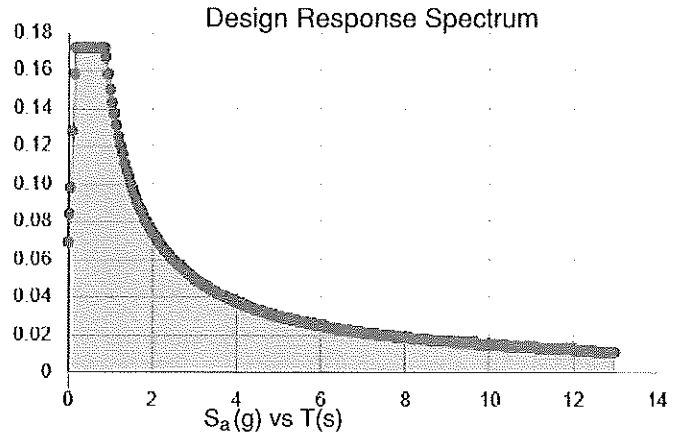
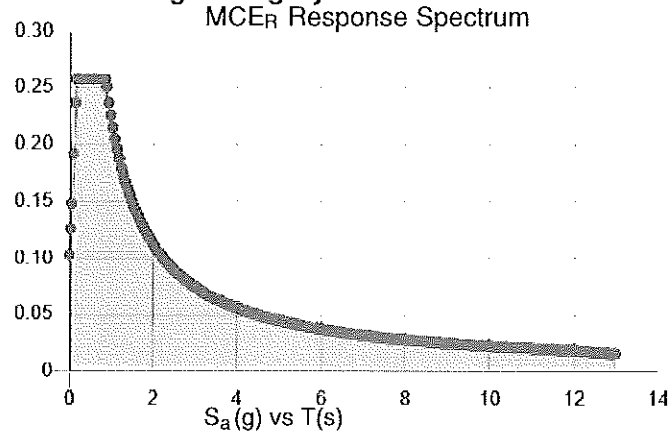
Site is not in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2.

**Site Soil Class:**

**Results:**

$S_S$ :	0.161	$S_{D1}$ :	0.15
$S_1$ :	0.094	$T_L$ :	12
$F_a$ :	1.6	PGA :	0.077
$F_v$ :	2.4	PGA <sub>M</sub> :	0.123
$S_{MS}$ :	0.258	$F_{PGA}$ :	1.6
$S_{M1}$ :	0.226	$I_e$ :	1.25
$S_{DS}$ :	0.172	$C_v$ :	0.7

**Seismic Design Category: C**



**Data Accessed:** Fri Sep 08 2023

**Date Source:**

USGS Seismic Design Maps based on ASCE/SEI 7-16 and ASCE/SEI 7-16 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-16 Ch. 21 are available from USGS.

## Snow

---

**Results:**

Ground Snow Load,  $p_g$  : 20 lb/ft<sup>2</sup>  
Mapped Elevation: 705.2 ft  
Data Source: ASCE/SEI 7-16, Table 7.2-8  
Date Accessed: Fri Sep 08 2023

Values provided are ground snow loads. In areas designated "case study required," extreme local variations in ground snow loads preclude mapping at this scale. Site-specific case studies are required to establish ground snow loads at elevations not covered.

Snow load values are mapped to a 0.5 mile resolution. This resolution can create a mismatch between the mapped elevation and the site-specific elevation in topographically complex areas. Engineers should consult the local authority having jurisdiction in locations where the reported 'elevation' and 'mapped elevation' differ significantly from each other.

## Rain

---

**Results:**

15-minute Precipitation Intensity: 7.32 in./h  
60-minute Precipitation Intensity: 3.53 in./h  
Data Source: NOAA National Weather Service, Precipitation Frequency Data Server, Atlas 14 (<https://www.nws.noaa.gov/oh/hdsc/>)  
Date Accessed: Fri Sep 08 2023

**Wind Loads :**

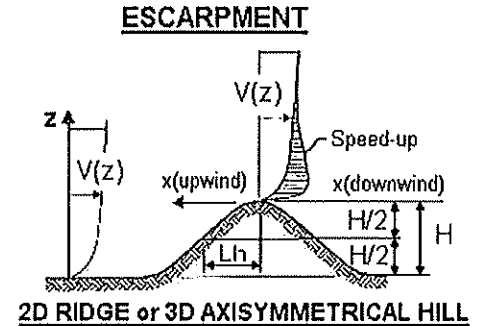
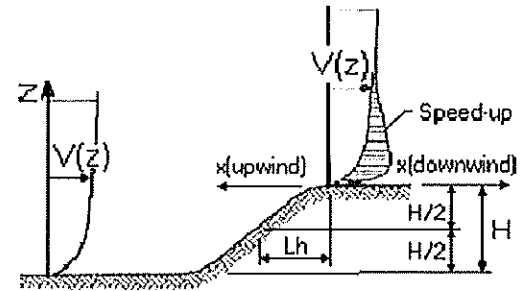
ASCE 7- 16

Ultimate Wind Speed	116 mph
Nominal Wind Speed	89.9 mph
Risk Category	III
Exposure Category	B
Enclosure Classif.	Enclosed Building
Internal pressure	+/-0.18
Directionality (Kd)	0.85
Kh case 1	0.771
Kh case 2	0.771
Type of roof	Monoslope

Topographic Factor (Kzt)

Topography	Flat
Hill Height (H)	0.0 ft
Half Hill Length (Lh)	0.0 ft
Actual H/Lh =	0.00
Use H/Lh =	0.00
Modified Lh =	0.0 ft
From top of crest: x =	0.0 ft
Bldg up/down wind?	downwind
H/Lh= 0.00	K <sub>1</sub> = 0.000
x/Lh = 0.00	K <sub>2</sub> = 0.000
z/Lh = 0.00	K <sub>3</sub> = 1.000
At Mean Roof Ht:	K <sub>z</sub> t = (1+K <sub>1</sub> K <sub>2</sub> K <sub>3</sub> ) <sup>2</sup> = 1.00

H < 60ft; exp B  
 ∴ K<sub>z</sub>t = 1.0



**Gust Effect Factor**

h =	42.0 ft
B =	400.0 ft
/z (0.6h) =	30.0 ft

Flexible structure if natural frequency < 1 Hz (T > 1 second).  
 If building h/B > 4 then may be flexible and should be investigated.  
 h/B = 0.11 Rigid structure (low rise bldg)

**G = 0.85** Using rigid structure default

Rigid Structure

$\bar{e}$ =	0.33
$\ell$ =	320 ft
$Z_{min}$ =	30 ft
c =	0.30
$g_Q, g_v$ =	3.4
$L_z$ =	310.0 ft
Q =	0.75
$I_z$ =	0.30
G =	0.78

Flexible or Dynamically Sensitive Structure

341cy ( $\eta_1$ ) =	0.0 Hz				
Damping ratio ( $\beta$ ) =	0				
$\gamma/b$ =	0.45				
$I/\alpha$ =	0.25				
$V_z$ =	74.8				
$N_1$ =	0.00				
$K_n$ =	0.000				
$R_h$ =	28.282	$\eta$ =	0.000	h =	42.0 ft
$R_B$ =	28.282	$\eta$ =	0.000		
$R_L$ =	28.282	$\eta$ =	0.000		
$g_R$ =	0.000				
R =	0.000				
Gf =	0.000				

**Wind Loads - Rooftop Structures & Canopies**

Ultimate Wind Pressures

Building (L) = 400.0 ft  
 Building (B) = 400.0 ft  
 Directionality (Kd) = 0.85

**Rooftop Structures & Equipment #1**

Equipment length parallel to L = 13.0 ft  
 Equipment length parallel to B = 11.0 ft  
 Height of equipment = 10.0 ft

Base pressure (qh) = 22.6 psf

<u>Vertical wind pressure</u>	<u>Wind normal to building B</u>	<u>Wind normal to building L</u>
Ar = 143.0 sf	Af = 110.0 sf	Af = 130.0 sf
GCr = 1.500	GCr = 1.90	GCr = 1.90
F = qhGCr Ar = 33.9 Ar (psf)	F = qhGCr Af = 42.9 Af (psf)	F = qhGCr Af = 42.9 Af (psf)
Fv = 4.8 kips	Fh = 4.7 kips	Fh = 5.6 kips

**Rooftop Structures & Equipment #2**

Equipment length parallel to L = 13.0 ft  
 Equipment length parallel to B = 11.0 ft  
 Height of equipment = 10.0 ft

Base pressure (qh) = 22.6 psf

<u>Vertical wind pressure</u>	<u>Wind normal to building B</u>	<u>Wind normal to building L</u>
Ar = 143.0 sf	Af = 110.0 sf	Af = 130.0 sf
GCr = 1.500	GCr = 1.90	GCr = 1.90
F = qhGCr Ar = 33.9 Ar (psf)	F = qhGCr Af = 42.9 Af (psf)	F = qhGCr Af = 42.9 Af (psf)
Fv = 4.8 kips	Fh = 4.7 kips	Fh = 5.6 kips

**Attached Canopies on Buildings with h ≤ 60 ft (ASCE 7-16 procedure)**

Mean Roof Ht (h) = 42.0 ft  
 Mean eave height (he) = 0.0 ft  
 Mean Canopy height (hc) = 0.0 ft

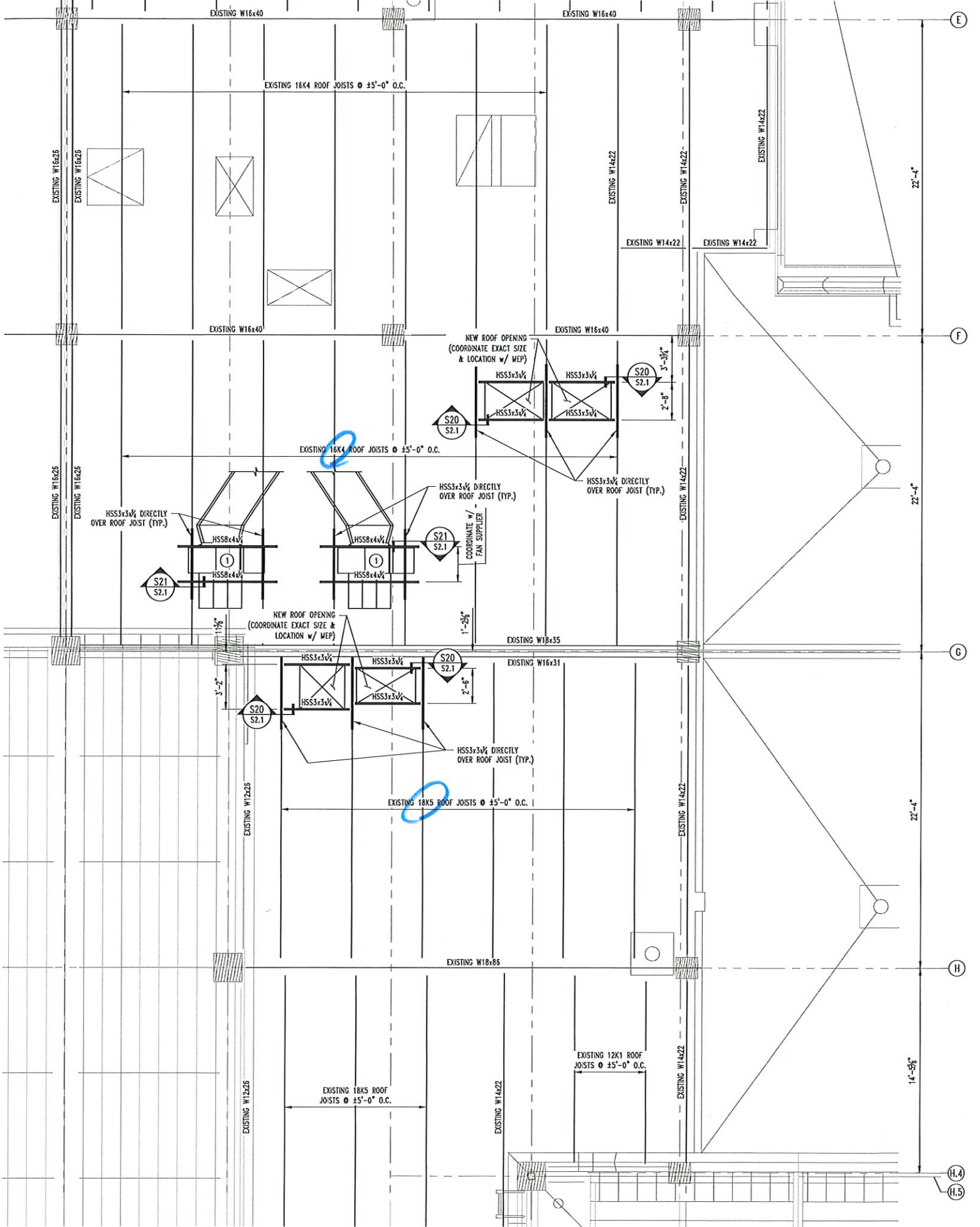
hc/he = #DIV/0!

Base pressure (qh) = 22.6 psf

Area	C&C Surface Pressure (psf)				User input
	10 sf	20 sf	50 sf	100 sf	
<b>Separate Individual Surfaces:</b>					
Upper surface negative pressure	-25.5	-24.5	-21.4	-16.3	-18.8
Lower surface negative pressure	-18.1	-17.7	-16.6	-14.7	-15.6
Upper or Lower surface pos pressure	18.1	17.6	16.1	13.6	14.8
<b>Combined Upper &amp; Lower Surfaces (net):</b>					
Negative pressure	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Positive pressure	19.8	19.1	17.3	14.2	15.8

Look @ Ex. Jorsts







## STANDARD LOAD TABLE FOR OPEN WEB STEEL JOISTS, K-SERIES

Based on a 50 ksi Maximum Yield Strength - Loads Shown in Pounds Per Linear Foot (plf)

Joist Designation	18K3		18K4		18K5		18K6		18K7		18K9		18K10		20K3		20K4		20K5		20K6		20K7		20K9		20K10		22K4		22K5		22K6		22K7		22K9		22K10											
	Depth (in.)	18	18	18	18	18	18	18	18	18	18	18	18	18	20	20	20	20	20	20	20	20	20	20	20	20	20	20	22	22	22	22	22	22	22	22	22	22												
Approx. Wt. (lbs./ft.)	6.4	7.2	7.7	8.4	8.9	10.1	11.6	6.5	7.2	7.7	8.4	8.9	10.1	11.6	6.5	7.2	7.7	8.4	8.9	10.1	11.6	6.5	7.2	7.7	8.4	8.9	10.1	11.6	6.5	7.2	7.7	8.4	8.9	10.1	11.6	6.5	7.2	7.7	8.4	8.9	10.1	11.6								
Span (ft.)																																																		
18	550	550	550	550	550	550	550																																											
19	514	550	550	550	550	550	550																																											
20	463	550	550	550	550	550	550																																											
21	420	506	550	550	550	550	550																																											
22	382	460	518	550	550	550	550																																											
23	341	420	473	516	550	550	550																																											
24	321	385	434	473	526	550	550																																											
25	294	355	400	435	485	550	550																																											
26	272	328	369	402	448	538	550																																											
27	190	222	249	271	299	354	361																																											
28	234	282	318	346	385	463	548																																											
29	218	263	296	322	359	431	511																																											
30	203	245	276	301	335	402	477																																											
31	190	229	258	281	313	376	446																																											
32	178	215	242	264	294	353	418																																											
33	168	202	228	248	276	332	393																																											
34	168	190	214	233	260	312	370																																											
35	149	179	202	220	245	294	349																																											
36	141	169	191	208	232	278	330																																											
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*365/5.0 ± 75plf*



Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

## General Beam Analysis

Project File: Brewer.ec6

LIC#: KW-06015690, Build:20.23.08.30

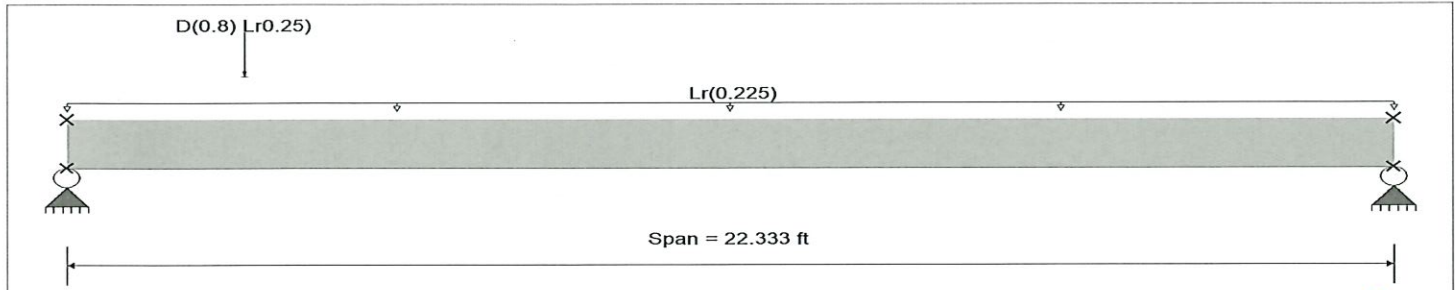
CROCKETT ENGINEERING CONSULTANTS

(c) ENERCALC INC 1983-2023

**DESCRIPTION:** joist capacity spanning 22.33' 18k5

### General Beam Properties

Elastic Modulus = 29,000.0 ksi  
 Span #1 Span Length = 22.333 ft Area = 10.0 in<sup>2</sup> Moment of Inertia = 100.0 in<sup>4</sup>



### Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Uniform Load : Lr = 0.2250 k/ft, Tributary Width = 1.0 ft

Point Load : D = 0.80, Lr = 0.250 k @ 3.0 ft

### DESIGN SUMMARY

Maximum Bending =	15.647 k-ft	Maximum Shear =	3.421 k
Load Combination	+D+Lr	Load Combination	+D+Lr
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Location of maximum on span	10.497 ft	Location of maximum on span	0.000 ft
Maximum Deflection			
Max Downward Transient Deflection	0.452 in		593
Max Upward Transient Deflection	0.007 in		37087
Max Downward Total Deflection	0.496 in		540
Max Upward Total Deflection	0.000 in		573766

*Handwritten notes:* 251 plf ← 500 plf thus OK (circled around 15.647 k-ft); 307 plf ← 500 plf thus OK (circled around 3.421 k).

### Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values (k-ft)					Shear Values (k)		
			M	V	Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Va Max
Overall MAXimum Envelope												
D Only	Dsgn. L = 22.33 ft	1			15.65		15.65					3.42
+D+Lr	Dsgn. L = 22.33 ft	1			2.08		2.08					0.69
+D+0.750Lr	Dsgn. L = 22.33 ft	1			15.65		15.65					3.42
+0.60D	Dsgn. L = 22.33 ft	1			12.05		12.05					2.74
	Dsgn. L = 22.33 ft	1			1.25		1.25					0.42

### Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+Lr	1	0.4956	11.055		0.0000	0.000

### Vertical Reactions

Load Combination	Support notation : Far left is #		Values in KIPS
	Support 1	Support 2	
Overall MAXimum	3.421	2.654	
Overall MINimum			
D Only	0.693	0.107	
+D+Lr	3.421	2.654	
+D+0.750Lr	2.739	2.017	
+0.60D	0.416	0.064	
Lr Only	2.729	2.546	

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

## General Beam Analysis

Project File: Brewer.ec6

LIC# : KW-06015690, Build:20.23.08.30

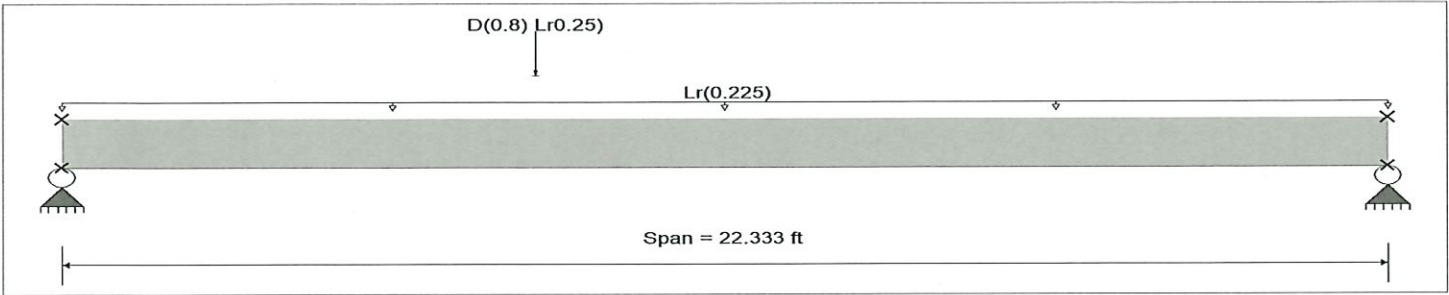
CROCKETT ENGINEERING CONSULTANTS

(c) ENERCALC INC 1983-2023

**DESCRIPTION:** worst case actual with equipment 22.333' 16k4 joist

### General Beam Properties

Elastic Modulus = 29,000.0 ksi  
 Span #1 Span Length = 22.333 ft Area = 10.0 in<sup>2</sup> Moment of Inertia = 100.0 in<sup>4</sup>



### Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Uniform Load : Lr = 0.2250 k/ft, Tributary Width = 1.0 ft, (45 psf x 5' joist spacing)

Point Load : D = 0.80, Lr = 0.250 k @ 8.0 ft, (equipment weight)

### DESIGN SUMMARY

Maximum Bending =	18.542 k-ft	Maximum Shear =	3.186 k
Load Combination	+D+Lr	Load Combination	+D+Lr
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Location of maximum on span	9.492 ft	Location of maximum on span	0.000 ft
Maximum Deflection			
Max Downward Transient Deflection	0.469 in	571	
Max Upward Transient Deflection	0.007 in	35911	
Max Downward Total Deflection	0.568 in	471	
Max Upward Total Deflection	0.001 in	290864	

*Handwritten notes: 298 plf < 390 plf thus OK (circled), 286 plf < 390 plf thus OK (circled)*

### Maximum Forces & Stresses for Load Combinations

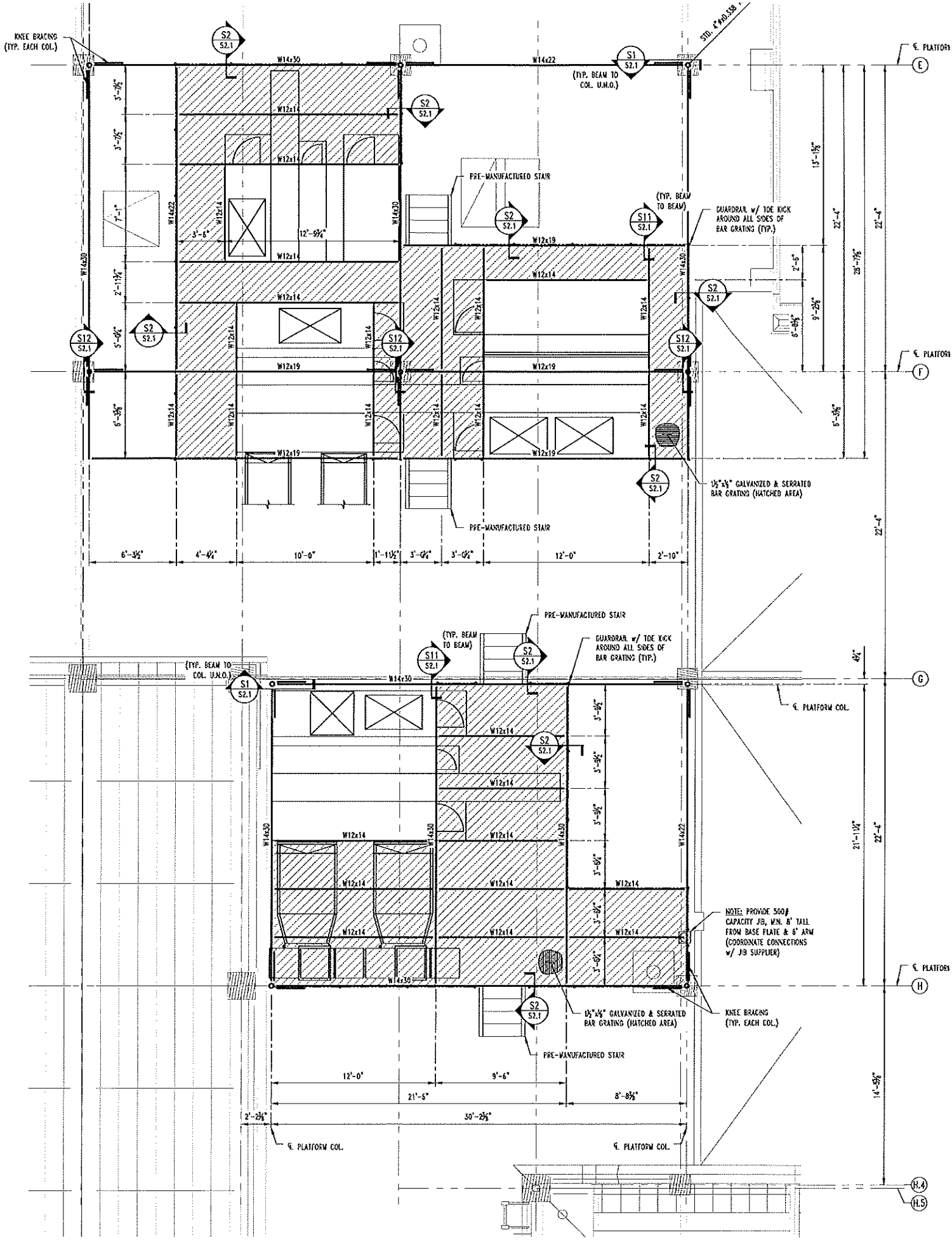
Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values (k-ft)					Shear Values (k)		
			M	V	Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Va Max
Overall MAXimum Envelope												
Dsgn. L =	22.33 ft	1			18.54		18.54				3.19	
D Only												
Dsgn. L =	22.33 ft	1			4.10		4.10				0.51	
+D+Lr												
Dsgn. L =	22.33 ft	1			18.54		18.54				3.19	
+D+0.750Lr												
Dsgn. L =	22.33 ft	1			14.84		14.84				2.52	
+0.60D												
Dsgn. L =	22.33 ft	1			2.46		2.46				0.31	

### Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+Lr	1	0.5684	11.055		0.0000	0.000

### Vertical Reactions

Load Combination	Support notation : Far left is #		Values in KIPS
	Support 1	Support 2	
Overall MAXimum	3.186	2.889	
Overall MINimum			
D Only	0.513	0.287	
+D+Lr	3.186	2.889	
+D+0.750Lr	2.518	2.238	
+0.60D	0.308	0.172	
Lr Only	2.673	2.602	



1  
S2.0

PARTIAL ROOF FRAMING PLAN @ PLATFORM LEVEL

SCALE: 1/4" = 1'-0"



NOTE:  
ALL STEEL GALVANIZED, COORDINATE  
DIMENSIONS w/ FINAL EQUIPMENT.

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**Steel Beam** Project File: Brewer.ec6  
 LIC# : KW-06015690, Build:20.23.08.30 CROCKETT ENGINEERING CONSULTANTS (c) ENERCALC INC 1983-2023

**DESCRIPTION:** 23' girder line 13.2

**CODE REFERENCES**

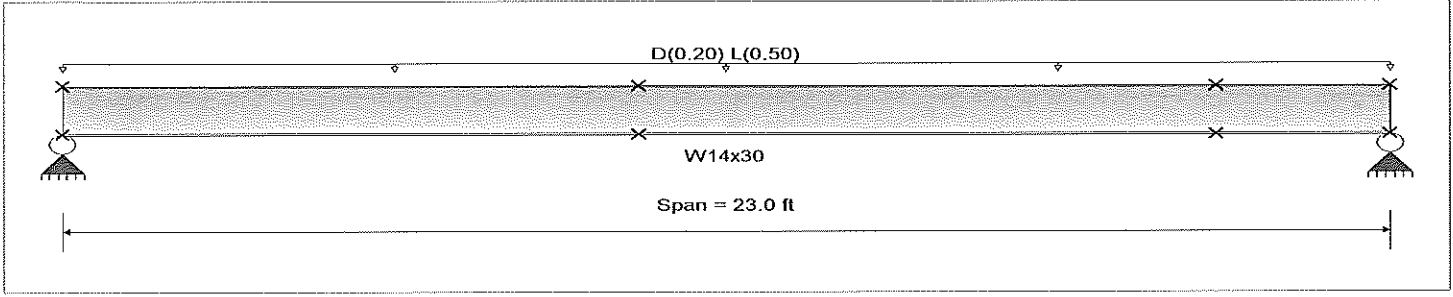
Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method : Allowable Strength Design Fy : Steel Yield : 50.0 ksi  
 Beam Bracing : Beam bracing is defined as a set spacing over all spans E: Modulus : 29,000.0 ksi  
 Bending Axis : Major Axis Bending

**Unbraced Lengths**

First Brace starts at 10.0 ft from Left-Most support  
 Regular spacing of lateral supports on length of beam = 10.0 ft



**Applied Loads**

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Uniform Load : D = 0.20, L = 0.50 k/ft, Tributary Width = 1.0 ft

**DESIGN SUMMARY**

**Design OK**

Maximum Bending Stress Ratio =	<b>0.436 : 1</b>	Maximum Shear Stress Ratio =	<b>0.108 : 1</b>
Section used for this span	<b>W14x30</b>	Section used for this span	<b>W14x30</b>
Ma : Applied	46.288 k-ft	Va : Applied	8.050 k
Mn / Omega : Allowable	106.221 k-ft	Vn/Omega : Allowable	74.520 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
		Span # where maximum occurs	Span # 1
<b>Maximum Deflection</b>			
Max Downward Transient Deflection	0.375 in Ratio = 736	>=360	Span: 1 : L Only
Max Upward Transient Deflection	0 in Ratio = 0	<360	n/a
Max Downward Total Deflection	0.525 in Ratio = 526	>=180	Span: 1 : +D+L
Max Upward Total Deflection	0 in Ratio = 0	<180	n/a

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
<b>D Only</b>														
Dsgn. L =	9.99 ft	1	0.110	0.031	13.00		13.00	197.08	118.01	1.37	1.00	2.30	111.78	74.52
Dsgn. L =	9.99 ft	1	0.125	0.023	13.23	6.04	13.23	177.39	106.22	1.11	1.00	1.70	111.78	74.52
Dsgn. L =	3.02 ft	1	0.051	0.031	6.04		6.04	197.08	118.01	1.59	1.00	2.30	111.78	74.52
<b>+D+L</b>														
Dsgn. L =	9.99 ft	1	0.385	0.108	45.49		45.49	197.08	118.01	1.37	1.00	8.05	111.78	74.52
Dsgn. L =	9.99 ft	1	0.436	0.080	46.29	21.14	46.29	177.39	106.22	1.11	1.00	5.93	111.78	74.52
Dsgn. L =	3.02 ft	1	0.179	0.108	21.14		21.14	197.08	118.01	1.59	1.00	8.05	111.78	74.52
<b>+D+0.750L</b>														
Dsgn. L =	9.99 ft	1	0.317	0.089	37.37		37.37	197.08	118.01	1.37	1.00	6.61	111.78	74.52
Dsgn. L =	9.99 ft	1	0.358	0.065	38.02	17.36	38.02	177.39	106.22	1.11	1.00	4.87	111.78	74.52
Dsgn. L =	3.02 ft	1	0.147	0.089	17.36		17.36	197.08	118.01	1.59	1.00	6.61	111.78	74.52
<b>+0.60D</b>														
Dsgn. L =	9.99 ft	1	0.066	0.019	7.80		7.80	197.08	118.01	1.37	1.00	1.38	111.78	74.52
Dsgn. L =	9.99 ft	1	0.075	0.014	7.94	3.62	7.94	177.39	106.22	1.11	1.00	1.02	111.78	74.52
Dsgn. L =	3.02 ft	1	0.031	0.019	3.62		3.62	197.08	118.01	1.59	1.00	1.38	111.78	74.52

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**Steel Beam**

Project File: Brewer.ec6

LIC# : KW-08015690, Build:20.23.08.30

CROCKETT ENGINEERING CONSULTANTS

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**DESCRIPTION:** 23' girder line 13.2

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.5247	11.566		0.0000	0.000

**Vertical Reactions**

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	8.050	8.050
Max Upward from Load Combinations	8.050	8.050
Max Upward from Load Cases	5.750	5.750
D Only	2.300	2.300
+D+L	8.050	8.050
+D+0.750L	6.613	6.613
+0.60D	1.380	1.380
L Only	5.750	5.750



Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**Steel Beam** Project File: Brewer.ec6  
 LIC# : KW-06015690, Build:20.23.08.30 CROCKETT ENGINEERING CONSULTANTS (c) ENERCALC INC 1983-2023

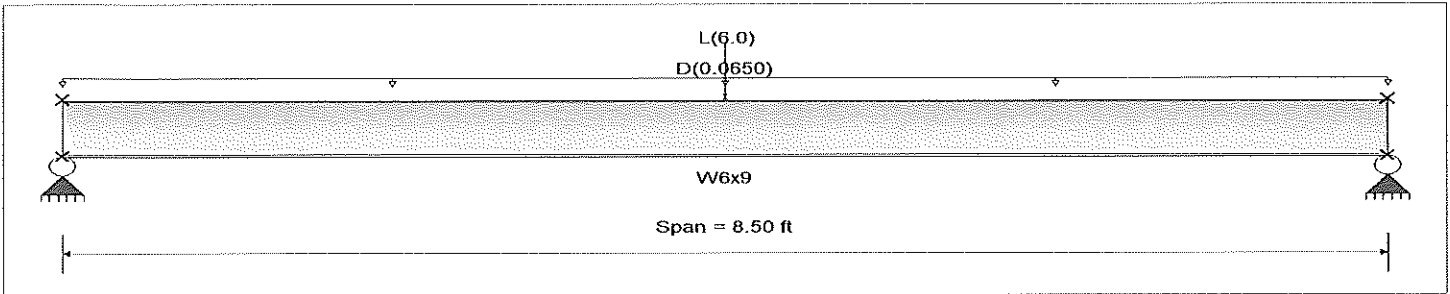
**DESCRIPTION:** beam at heat pump in basement 500 psf

**CODE REFERENCES**

Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method : Allowable Strength Design	Fy : Steel Yield :	50.0 ksi
Beam Bracing : Completely Unbraced	E: Modulus :	29,000.0 ksi
Bending Axis : Major Axis Bending		



**Applied Loads**

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Uniform Load : D = 0.0650 k/ft, Tributary Width = 1.0 ft

Point Load : L = 6.0 k @ 4.250 ft

**DESIGN SUMMARY**

**Design OK**

Maximum Bending Stress Ratio =	0.943 : 1	Maximum Shear Stress Ratio =	0.163 : 1
Section used for this span	<b>W6x9</b>	Section used for this span	<b>W6x9</b>
Ma : Applied	13.337 k-ft	Va : Applied	3.276 k
Mn / Omega : Allowable	14.145 k-ft	Vn/Omega : Allowable	20.060 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
		Span # where maximum occurs	Span # 1
<b>Maximum Deflection</b>			
Max Downward Transient Deflection	0.280 in	Ratio =	364 >=360
Max Upward Transient Deflection	0 in	Ratio =	0 <360
Max Downward Total Deflection	0.296 in	Ratio =	344 >=180
Max Upward Total Deflection	0 in	Ratio =	0 <180
		Span: 1 : L Only	
		Span: 1 : +D+L	

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
D Only	Dsgn. L = 8.50 ft	1	0.048	0.014	0.59		0.59	20.53	12.29	1.14	1.00	0.28	30.09	20.06
+D+L	Dsgn. L = 8.50 ft	1	0.943	0.163	13.34		13.34	23.62	14.14	1.31	1.00	3.28	30.09	20.06
+D+0.750L	Dsgn. L = 8.50 ft	1	0.719	0.126	10.15		10.15	23.57	14.11	1.30	1.00	2.53	30.09	20.06
+0.60D	Dsgn. L = 8.50 ft	1	0.029	0.008	0.35		0.35	20.53	12.29	1.14	1.00	0.17	30.09	20.06

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.2962	4.274		0.0000	0.000

**Vertical Reactions**

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	3.276	3.276
Max Upward from Load Combinations	3.276	3.276
Max Upward from Load Cases	3.000	3.000
D Only	0.276	0.276
+D+L	3.276	3.276

Project Title:  
Engineer:  
Project ID:  
Project Descr:

**Steel Beam**

Project File: Brewer.ec6

LIC# : KW-06015690, Build:20.23.08.30

CROCKETT ENGINEERING CONSULTANTS

(c) ENERCALC INC 1983-2023

**DESCRIPTION:** beam at heat pump in basement 500 psf

**Vertical Reactions**

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
+D+0.750L	2.526	2.526
+0.60D	0.166	0.166
L Only	3.000	3.000

<b>Steel Beam</b>	Project File: Brewer.ec6
LIC#: KW-06015690, Build:20.23.08.30	CROCKETT ENGINEERING CONSULTANTS
(c) ENERCALC INC 1983-2023	

**DESCRIPTION:** 23' girder line 14

**CODE REFERENCES**

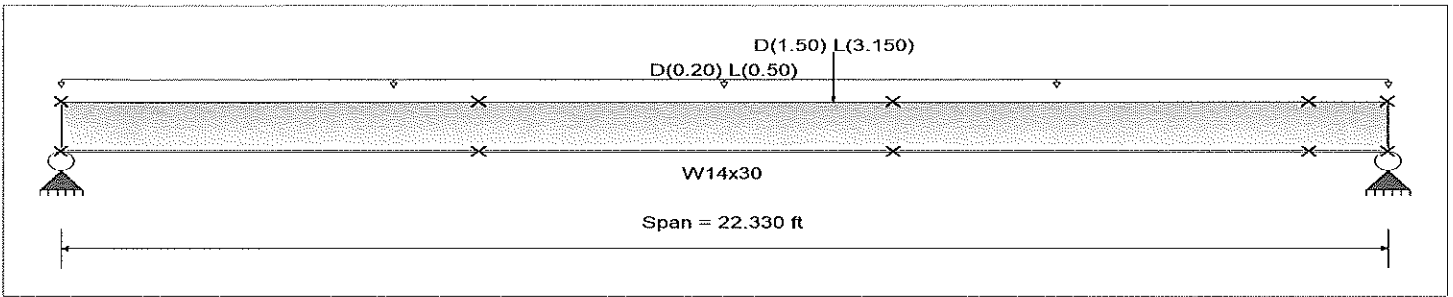
Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method: Allowable Strength Design	Fy : Steel Yield :	50.0 ksi
Beam Bracing : Beam bracing is defined as a set spacing over all spans	E: Modulus :	29,000.0 ksi
Bending Axis : Major Axis Bending		

**Unbraced Lengths**

First Brace starts at 7.0 ft from Left-Most support  
 Regular spacing of lateral supports on length of beam = 7.0 ft



**Applied Loads**

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Uniform Load : D = 0.20, L = 0.50 k/ft, Tributary Width = 1.0 ft  
  
 Point Load : D = 1.50, L = 3.150 k @ 13.0 ft

**DESIGN SUMMARY**

**Design OK**

Maximum Bending Stress Ratio = <b>0.583 : 1</b> Section used for this span <b>W14x30</b> Ma : Applied <b>67.676 k-ft</b> Mn / Omega : Allowable <b>116.115 k-ft</b> Load Combination <b>+D+L</b> Span # where maximum occurs <b>Span # 1</b>	Maximum Shear Stress Ratio = <b>0.141 : 1</b> Section used for this span <b>W14x30</b> Va : Applied <b>10.523 k</b> Vn/Omega : Allowable <b>74.520 k</b> Load Combination <b>+D+L</b> Location of maximum on span <b>22.330 ft</b> Span # where maximum occurs <b>Span # 1</b>
<b>Maximum Deflection</b> Max Downward Transient Deflection <b>0.477 in Ratio = 561 &gt;=240. Span: 1 : L Only</b> Max Upward Transient Deflection <b>0 in Ratio = 0 &lt;240.0 n/a</b> Max Downward Total Deflection <b>0.680 in Ratio = 394 &gt;=180 Span: 1 : +D+L</b> Max Upward Total Deflection <b>0 in Ratio = 0 &lt;180 n/a</b>	

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values					Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
<b>D Only</b>														
Dsgn. L =	6.95 ft	1	0.128	0.038	15.05		15.05	197.08	118.01	1.54	1.00	2.86	111.78	74.52
Dsgn. L =	7.02 ft	1	0.174	0.020	20.26	15.05	20.26	194.83	116.66	1.06	1.00	1.47	111.78	74.52
Dsgn. L =	7.02 ft	1	0.161	0.038	18.98	3.98	18.98	197.08	118.01	1.37	1.00	2.84	111.78	74.52
Dsgn. L =	1.34 ft	1	0.034	0.042	3.98		3.98	197.08	118.01	1.60	1.00	3.11	111.78	74.52
<b>+D+L</b>														
Dsgn. L =	6.95 ft	1	0.432	0.131	50.94		50.94	197.08	118.01	1.53	1.00	9.76	111.78	74.52
Dsgn. L =	7.02 ft	1	0.583	0.066	67.68	50.94	67.68	193.91	116.12	1.06	1.00	4.89	111.78	74.52
Dsgn. L =	7.02 ft	1	0.538	0.129	63.50	13.47	63.50	197.08	118.01	1.37	1.00	9.58	111.78	74.52
Dsgn. L =	1.34 ft	1	0.114	0.141	13.47		13.47	197.08	118.01	1.60	1.00	10.52	111.78	74.52
<b>+D+0.750L</b>														
Dsgn. L =	6.95 ft	1	0.356	0.108	41.96		41.96	197.08	118.01	1.53	1.00	8.03	111.78	74.52
Dsgn. L =	7.02 ft	1	0.480	0.054	55.82	41.96	55.82	194.10	116.22	1.06	1.00	4.04	111.78	74.52
Dsgn. L =	7.02 ft	1	0.444	0.106	52.37	11.10	52.37	197.08	118.01	1.37	1.00	7.90	111.78	74.52
Dsgn. L =	1.34 ft	1	0.094	0.116	11.10		11.10	197.08	118.01	1.60	1.00	8.67	111.78	74.52
<b>+0.60D</b>														

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

<b>Steel Beam</b>	Project File: Brewer.ec6
LIC# : KW-06015690, Build:20.23.08.30	CROCKETT ENGINEERING CONSULTANTS
	(c) ENERCALC INC 1983-2023

**DESCRIPTION:** 23' girder line 14

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	VnxVnx/Omega	
Dsgn. L =	6.95 ft	1	0.077	0.023	9.03		9.03	197.08	118.01	1.54	1.00	1.72	111.78	74.52
Dsgn. L =	7.02 ft	1	0.104	0.012	12.16	9.03	12.16	194.83	116.66	1.06	1.00	0.88	111.78	74.52
Dsgn. L =	7.02 ft	1	0.096	0.023	11.39	2.39	11.39	197.08	118.01	1.37	1.00	1.70	111.78	74.52
Dsgn. L =	1.34 ft	1	0.020	0.025	2.39		2.39	197.08	118.01	1.60	1.00	1.86	111.78	74.52

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.6797	11.356		0.0000	0.000

**Vertical Reactions**

Load Combination	Support notation : Far left is #		Values in KIPS	
	Support 1	Support 2		
Max Upward from all Load Conditions	9.758	10.523		
Max Upward from Load Combinations	9.758	10.523		
Max Upward from Load Cases	6.899	7.416		
D Only	2.860	3.106		
+D+L	9.758	10.523		
+D+0.750L	8.034	8.669		
+0.60D	1.716	1.864		
L Only	6.899	7.416		

<b>Steel Beam</b>	Project File: Brewer.ec6
LIC# : KW-06015690, Build:20.23.08.30	CROCKETT ENGINEERING CONSULTANTS
(c) ENERCALC INC 1983-2023	

**DESCRIPTION:** 22' girder grid E

**CODE REFERENCES**

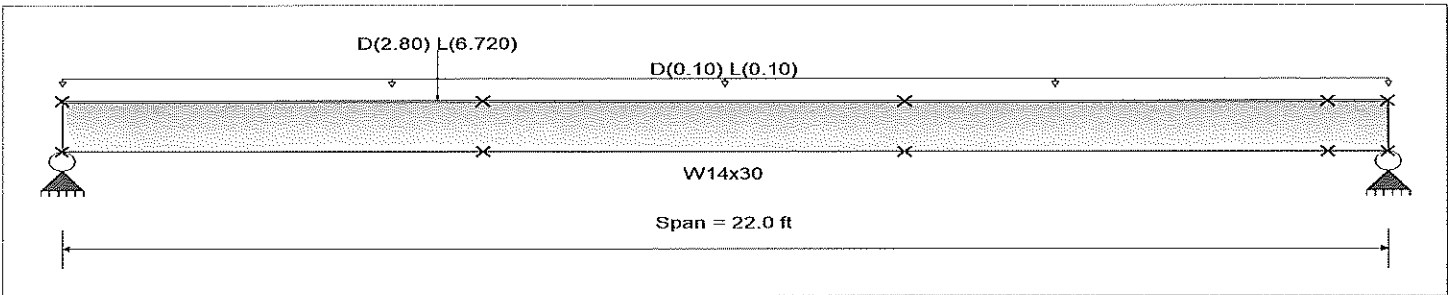
Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method : Allowable Strength Design	Fy : Steel Yield : 50.0 ksi
Beam Bracing : Beam bracing is defined as a set spacing over all spans	E: Modulus : 29,000.0 ksi
Bending Axis : Major Axis Bending	

**Unbraced Lengths**

First Brace starts at 7.0 ft from Left-Most support  
 Regular spacing of lateral supports on length of beam = 7.0 ft



**Applied Loads**

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Uniform Load : D = 0.10, L = 0.10 k/ft, Tributary Width = 1.0 ft  
  
 Point Load : D = 2.80, L = 6.720 k @ 6.250 ft

**DESIGN SUMMARY**

**Design OK**

Maximum Bending Stress Ratio =	0.444 : 1	Maximum Shear Stress Ratio =	0.121 : 1
Section used for this span	<b>W14x30</b>	Section used for this span	<b>W14x30</b>
Ma : Applied	52.378 k-ft	Va : Applied	9.015 k
Mn / Omega : Allowable	118.014 k-ft	Vn/Omega : Allowable	74.520 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
<b>Maximum Deflection</b>			
Max Downward Transient Deflection	0.298 in Ratio = 884	>=240.0	Span: 1 : L Only
Max Upward Transient Deflection	0 in Ratio = 0	<240.0	n/a
Max Downward Total Deflection	0.459 in Ratio = 575	>=180	Span: 1 : +D+L
Max Upward Total Deflection	0 in Ratio = 0	<180	n/a

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
<b>D Only</b>														
Dsgn. L =	6.98 ft	1	0.148	0.042	17.44		17.44	197.08	118.01	1.51	1.00	3.10	111.78	74.52
Dsgn. L =	6.98 ft	1	0.146	0.015	17.19	12.01	17.19	197.08	118.01	1.11	1.00	1.09	111.78	74.52
Dsgn. L =	7.04 ft	1	0.102	0.024	12.01	1.86	12.01	197.08	118.01	1.44	1.00	1.79	111.78	74.52
Dsgn. L =	1.01 ft	1	0.016	0.025	1.86		1.86	197.08	118.01	1.65	1.00	1.90	111.78	74.52
<b>+D+L</b>														
Dsgn. L =	6.98 ft	1	0.444	0.121	52.38		52.38	197.08	118.01	1.53	1.00	9.02	111.78	74.52
Dsgn. L =	6.98 ft	1	0.433	0.044	51.11	32.99	51.11	197.08	118.01	1.14	1.00	3.30	111.78	74.52
Dsgn. L =	7.04 ft	1	0.280	0.063	32.99	4.83	32.99	197.08	118.01	1.46	1.00	4.70	111.78	74.52
Dsgn. L =	1.01 ft	1	0.041	0.066	4.83		4.83	197.08	118.01	1.66	1.00	4.90	111.78	74.52
<b>+D+0.750L</b>														
Dsgn. L =	6.98 ft	1	0.370	0.101	43.64		43.64	197.08	118.01	1.53	1.00	7.54	111.78	74.52
Dsgn. L =	6.98 ft	1	0.361	0.037	42.63	27.74	42.63	197.08	118.01	1.14	1.00	2.74	111.78	74.52
Dsgn. L =	7.04 ft	1	0.235	0.053	27.74	4.09	27.74	197.08	118.01	1.46	1.00	3.98	111.78	74.52
Dsgn. L =	1.01 ft	1	0.035	0.056	4.09		4.09	197.08	118.01	1.66	1.00	4.15	111.78	74.52
<b>+0.60D</b>														

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

<b>Steel Beam</b>	Project File: Brewer.ec6
LIC# : KW-06015690, Build:20.23.08.30	CROCKETT ENGINEERING CONSULTANTS
(c) ENERCALC INC 1983-2023	

**DESCRIPTION:** 22' girder grid E

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
Dsgn. L =	6.98 ft	1	0.089	0.025	10.46		10.46	197.08	118.01	1.51	1.00	1.86	111.78	74.52
Dsgn. L =	6.98 ft	1	0.087	0.009	10.31	7.21	10.31	197.08	118.01	1.11	1.00	0.65	111.78	74.52
Dsgn. L =	7.04 ft	1	0.061	0.014	7.21	1.11	7.21	197.08	118.01	1.44	1.00	1.08	111.78	74.52
Dsgn. L =	1.01 ft	1	0.009	0.015	1.11		1.11	197.08	118.01	1.65	1.00	1.14	111.78	74.52

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.4594	10.183		0.0000	0.000

**Vertical Reactions**

Load Combination	Support notation : Far left is #		Values in KIPS	
	Support 1	Support 2		
Max Upward from all Load Conditions	9.015	4.905		
Max Upward from Load Combinations	9.015	4.905		
Max Upward from Load Cases	5.911	3.009		
D Only	3.105	1.895		
+D+L	9.015	4.905		
+D+0.750L	7.538	4.152		
+0.60D	1.863	1.137		
L Only	5.911	3.009		

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

<b>Steel Beam</b>	Project File: Brewer.ec6
LIC#: KW-06015690, Build:20.23.08.30	(c) ENERCALC INC 1983-2023

CROCKETT ENGINEERING CONSULTANTS

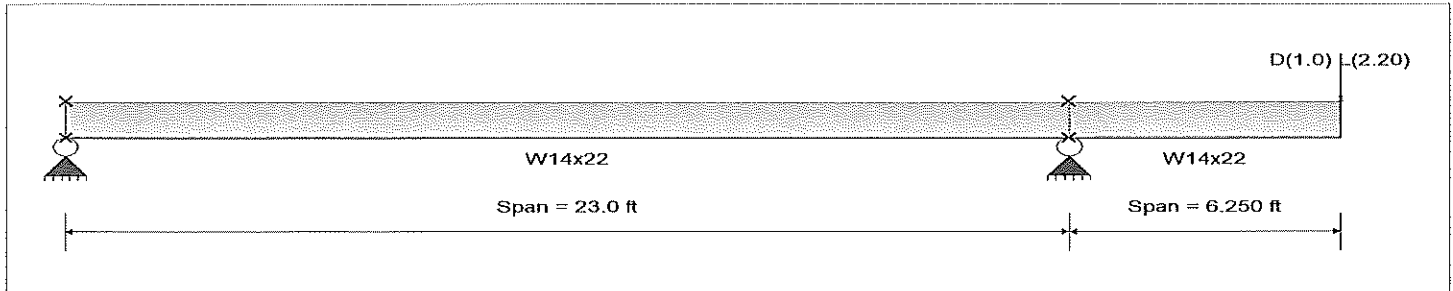
**DESCRIPTION:** 23' girder line 13

**CODE REFERENCES**

Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method : Allowable Strength Design	Fy : Steel Yield : 50.0 ksi
Beam Bracing : Completely Unbraced	E : Modulus : 29,000.0 ksi
Bending Axis : Major Axis Bending	



**Applied Loads**

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Load(s) for Span Number 2  
 Point Load : D = 1.0, L = 2.20 k @ 6.250 ft

**DESIGN SUMMARY**

Design OK

Maximum Bending Stress Ratio = <b>0.792 : 1</b> Section used for this span <b>W14x22</b> Ma : Applied 20.000 k-ft Mn / Omega : Allowable 25.263 k-ft Load Combination +D+L Span # where maximum occurs Span # 1	Maximum Shear Stress Ratio = <b>0.051 : 1</b> Section used for this span <b>W14x22</b> Va : Applied 3.20 k Vn/Omega : Allowable 63.020 k Load Combination +D+L Location of maximum on span 23.000 ft Span # where maximum occurs Span # 1
<b>Maximum Deflection</b> Max Downward Transient Deflection 0.251 in Ratio = 598 >=240. Span: 2 : L Only Max Upward Transient Deflection -0.140 in Ratio = 1,965 >=240. Span: 2 : L Only Max Downward Total Deflection 0.365 in Ratio = 411 >=180. Span: 2 : +D+L Max Upward Total Deflection -0.204 in Ratio = 1351 >=180. Span: 2 : +D+L	

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values		
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx
<b>D Only</b>													
Dsgn. L =	23.00 ft	1	0.247	0.016	-6.25	6.25	42.19	25.26	1.67	1.00	1.00	94.53	63.02
Dsgn. L =	6.25 ft	2	0.089	0.016	-6.25	6.25	117.87	70.58	1.00	1.00	1.00	94.53	63.02
<b>+D+L</b>													
Dsgn. L =	23.00 ft	1	0.792	0.051	-20.00	20.00	42.19	25.26	1.67	1.00	3.20	94.53	63.02
Dsgn. L =	6.25 ft	2	0.283	0.051	-20.00	20.00	117.87	70.58	1.00	1.00	3.20	94.53	63.02
<b>+D+0.750L</b>													
Dsgn. L =	23.00 ft	1	0.656	0.042	-16.56	16.56	42.19	25.26	1.67	1.00	2.65	94.53	63.02
Dsgn. L =	6.25 ft	2	0.235	0.042	-16.56	16.56	117.87	70.58	1.00	1.00	2.65	94.53	63.02
<b>+0.60D</b>													
Dsgn. L =	23.00 ft	1	0.148	0.010	-3.75	3.75	42.19	25.26	1.67	1.00	0.60	94.53	63.02
Dsgn. L =	6.25 ft	2	0.053	0.010	-3.75	3.75	117.87	70.58	1.00	1.00	0.60	94.53	63.02

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
	1	0.0000	0.000	+D+L	-0.2043	13.340
+D+L	2	0.3647	6.250		0.0000	13.340

**Vertical Reactions**

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Max Upward from all Load Conditions		4.070	

Project Title:  
Engineer:  
Project ID:  
Project Descr:

**Steel Beam**

Project File: Brewer.ec6

LIC#: KW-06015690, Build:20.23.08.30

CROCKETT ENGINEERING CONSULTANTS

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**DESCRIPTION:** 23' girder line 13

**Vertical Reactions**

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Max Upward from Load Combinations		4.070	
Max Upward from Load Cases		2.798	
Max Downward from all Load Conditions (Resist)	-0.870		
Max Downward from Load Combinations (Resist)	-0.870		
Max Downward from Load Cases (Resisting Uplift)	-0.598		
D Only	-0.272	1.272	
+D+L	-0.870	4.070	
+D+0.750L	-0.720	3.370	
+0.60D	-0.163	0.763	
L Only	-0.598	2.798	



Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**Steel Beam** Project File: Brewer.ec6  
 LIC#: KW-06015690, Build:20.23.08.30 CROCKETT ENGINEERING CONSULTANTS (c) ENERCALC INC 1983-2023

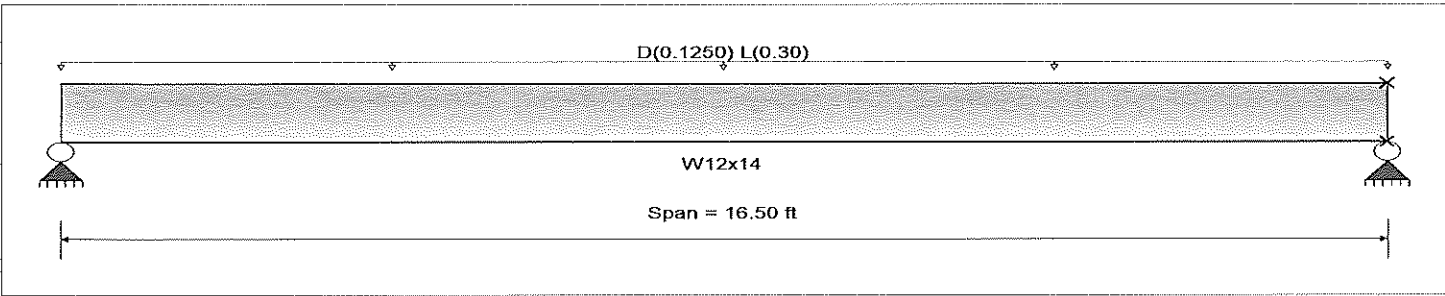
**DESCRIPTION:** 16.0' beam with 5' trib

**CODE REFERENCES**

Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method Allowable Strength Design Fy : Steel Yield : 50.0 ksi  
 Beam Bracing : Beam is Fully Braced against lateral-torsional buckling E: Modulus : 29,000.0 ksi  
 Bending Axis : Major Axis Bending



**Applied Loads** Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Uniform Load : D = 0.1250, L = 0.30 k/ft, Tributary Width = 1.0 ft

**DESIGN SUMMARY**

**Design OK**

Maximum Bending Stress Ratio =	<b>0.333 : 1</b>	Maximum Shear Stress Ratio =	<b>0.082 : 1</b>
Section used for this span	<b>W12x14</b>	Section used for this span	<b>W12x14</b>
Ma : Applied	14.463 k-ft	Va : Applied	3.506 k
Mn / Omega : Allowable	43.413 k-ft	Vn/Omega : Allowable	42.754 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
		Span # where maximum occurs	Span # 1
<b>Maximum Deflection</b>			
Max Downward Transient Deflection	0.196 in	Ratio = 1,012	>=240. Span: 1 : L Only
Max Upward Transient Deflection	0 in	Ratio = 0	<240.0 n/a
Max Downward Total Deflection	0.277 in	Ratio = 715	>=180 Span: 1 : +D+L
Max Upward Total Deflection	0 in	Ratio = 0	<180 n/a

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
<b>D Only</b>														
Dsgn. L =	16.50 ft	1	0.098	0.024	4.25		4.25	72.50	43.41	1.00	1.00	1.03	71.40	42.75
<b>+D+L</b>														
Dsgn. L =	16.50 ft	1	0.333	0.082	14.46		14.46	72.50	43.41	1.00	1.00	3.51	71.40	42.75
<b>+D+0.750L</b>														
Dsgn. L =	16.50 ft	1	0.274	0.068	11.91		11.91	72.50	43.41	1.00	1.00	2.89	71.40	42.75
<b>+0.60D</b>														
Dsgn. L =	16.50 ft	1	0.059	0.014	2.55		2.55	72.50	43.41	1.00	1.00	0.62	71.40	42.75

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.2771	8.297		0.0000	0.000

**Vertical Reactions**

Load Combination	Support notation : Far left is #		Values in KIPS	
	Support 1	Support 2		
Max Upward from all Load Conditions	3.506	3.506		
Max Upward from Load Combinations	3.506	3.506		
Max Upward from Load Cases	2.475	2.475		
D Only	1.031	1.031		
+D+L	3.506	3.506		
+D+0.750L	2.888	2.888		
+0.60D	0.619	0.619		

Project Title:  
Engineer:  
Project ID:  
Project Descr:

**Steel Beam**

Project File: Brewer.ec6

LIC# : KW-06015690, Build:20.23.08.30

CROCKETT ENGINEERING CONSULTANTS

(c) ENERCALC INC 1983-2023

**DESCRIPTION:** 16.0' beam with 5' trib

**Vertical Reactions**

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	2.475	2.475

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

<b>Steel Beam</b>	Project File: Brewer.ec6
LIC# : KW-06015690, Build:20.23.08.30	(c) ENERCALC INC 1983-2023

CROCKETT ENGINEERING CONSULTANTS

**DESCRIPTION:** 22' girder grid F.5

**CODE REFERENCES**

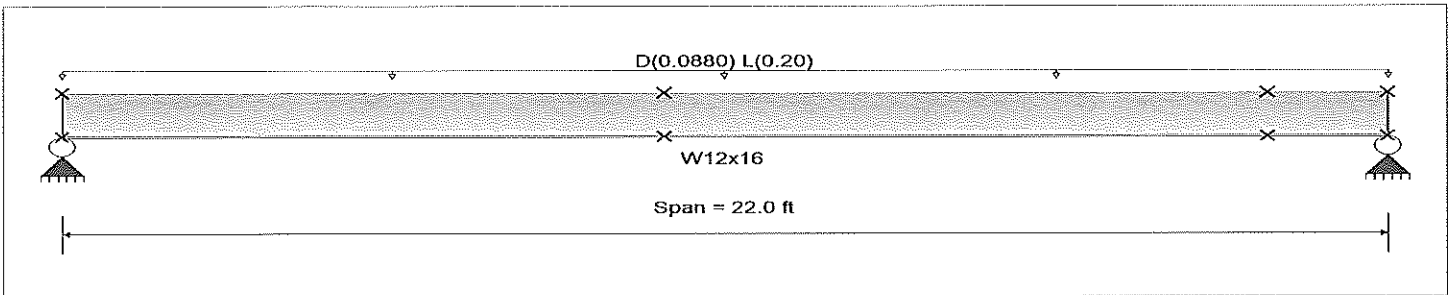
Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method Allowable Strength Design	Fy : Steel Yield : 50.0 ksi
Beam Bracing : Beam bracing is defined as a set spacing over all spans	E: Modulus : 29,000.0 ksi
Bending Axis : Major Axis Bending	

**Unbraced Lengths**

First Brace starts at 10.0 ft from Left-Most support  
 Regular spacing of lateral supports on length of beam = 10.0 ft



**Applied Loads**

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Uniform Load : D = 0.0880, L = 0.20 k/ft, Tributary Width = 1.0 ft

**DESIGN SUMMARY**

**Design OK**

Maximum Bending Stress Ratio = <b>0.732 : 1</b> Section used for this span <b>W12x16</b> Ma : Applied 17.424 k-ft Mn / Omega : Allowable 23.803 k-ft Load Combination +D+L Span # where maximum occurs Span # 1	Maximum Shear Stress Ratio = <b>0.060 : 1</b> Section used for this span <b>W12x16</b> Va : Applied 3.168 k Vn/Omega : Allowable 52.80 k Load Combination +D+L Location of maximum on span 0.000 ft Span # where maximum occurs Span # 1
<b>Maximum Deflection</b> Max Downward Transient Deflection 0.354 in Ratio = 744 >=240. Span: 1 : L Only Max Upward Transient Deflection 0 in Ratio = 0 <240.0 n/a Max Downward Total Deflection 0.511 in Ratio = 517 >=180 Span: 1 : +D+L Max Upward Total Deflection 0 in Ratio = 0 <180 n/a	

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	VnxVnx/Omega	
<b>D Only</b>														
Dsgn. L =	9.99 ft	1	0.188	0.018	5.28		5.28	46.88	28.07	1.35	1.00	0.97	79.20	52.80
Dsgn. L =	9.99 ft	1	0.224	0.015	5.32	1.77	5.32	39.75	23.80	1.15	1.00	0.79	79.20	52.80
Dsgn. L =	2.01 ft	1	0.035	0.018	1.77		1.77	83.75	50.15	1.62	1.00	0.97	79.20	52.80
<b>+D+L</b>														
Dsgn. L =	9.99 ft	1	0.615	0.060	17.28		17.28	46.88	28.07	1.35	1.00	3.17	79.20	52.80
Dsgn. L =	9.99 ft	1	0.732	0.049	17.42	5.79	17.42	39.75	23.80	1.15	1.00	2.59	79.20	52.80
Dsgn. L =	2.01 ft	1	0.115	0.060	5.79		5.79	83.75	50.15	1.62	1.00	3.17	79.20	52.80
<b>+D+0.750L</b>														
Dsgn. L =	9.99 ft	1	0.509	0.050	14.28		14.28	46.88	28.07	1.35	1.00	2.62	79.20	52.80
Dsgn. L =	9.99 ft	1	0.605	0.041	14.40	4.78	14.40	39.75	23.80	1.15	1.00	2.14	79.20	52.80
Dsgn. L =	2.01 ft	1	0.095	0.050	4.78		4.78	83.75	50.15	1.62	1.00	2.62	79.20	52.80
<b>+0.60D</b>														
Dsgn. L =	9.99 ft	1	0.113	0.011	3.17		3.17	46.88	28.07	1.35	1.00	0.58	79.20	52.80
Dsgn. L =	9.99 ft	1	0.134	0.009	3.19	1.06	3.19	39.75	23.80	1.15	1.00	0.47	79.20	52.80
Dsgn. L =	2.01 ft	1	0.021	0.011	1.06		1.06	83.75	50.15	1.62	1.00	0.58	79.20	52.80

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

<b>Steel Beam</b>	Project File: Brewer.ec6
-------------------	--------------------------

LIC# : KW-06015690, Build:20.23.08.30

CROCKETT ENGINEERING CONSULTANTS

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**DESCRIPTION:** 22' girder grid F.5

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.5105	11.063		0.0000	0.000

**Vertical Reactions**

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	3.168	3.168
Max Upward from Load Combinations	3.168	3.168
Max Upward from Load Cases	2.200	2.200
D Only	0.968	0.968
+D+L	3.168	3.168
+D+0.750L	2.618	2.618
+0.60D	0.581	0.581
L Only	2.200	2.200

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

<b>Steel Beam</b>	Project File: Brewer.ec6
LIC#: KW-06015690, Build:20.23.08.30	CROCKETT ENGINEERING CONSULTANTS
(c) ENERCALC INC 1983-2023	

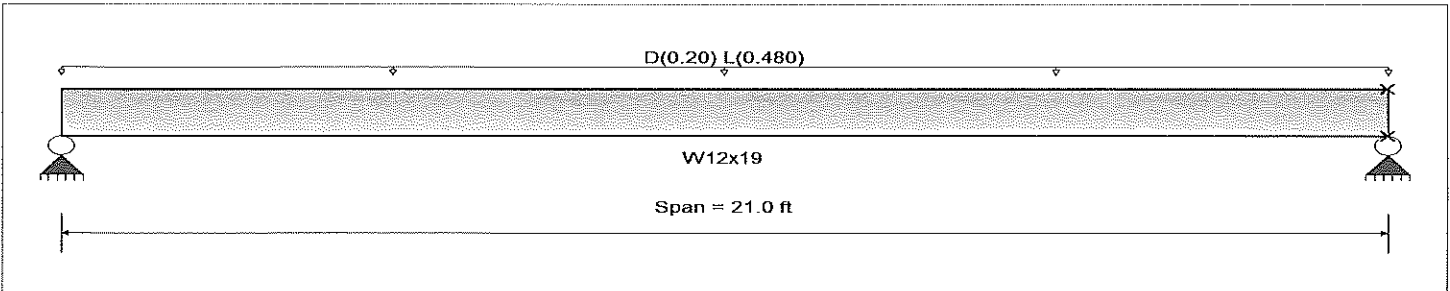
**DESCRIPTION:** 21' girder grid F

**CODE REFERENCES**

Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method: Allowable Strength Design	Fy : Steel Yield : 50.0 ksi
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling	E: Modulus : 29,000.0 ksi
Bending Axis : Major Axis Bending	



**Applied Loads** Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Uniform Load : D = 0.20, L = 0.480 k/ft, Tributary Width = 1.0 ft

**DESIGN SUMMARY**

**Design OK**

Maximum Bending Stress Ratio =	<b>0.608 : 1</b>	Maximum Shear Stress Ratio =	<b>0.125 : 1</b>
Section used for this span	<b>W12x19</b>	Section used for this span	<b>W12x19</b>
Ma : Applied	37.485 k-ft	Va : Applied	7.140 k
Mn / Omega : Allowable	61.627 k-ft	Vn/Omega : Allowable	57.340 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
<b>Maximum Deflection</b>			
Max Downward Transient Deflection	0.559 in	Ratio = 450	>=240.0
Max Upward Transient Deflection	0 in	Ratio = 0	<240.0
Max Downward Total Deflection	0.793 in	Ratio = 318	>=180
Max Upward Total Deflection	0 in	Ratio = 0	<180
			n/a

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
<b>D Only</b>														
Dsgn. L =	21.00 ft	1	0.179	0.037	11.03		11.03	102.92	61.63	1.00	1.00	2.10	86.01	57.34
<b>+D+L</b>														
Dsgn. L =	21.00 ft	1	0.608	0.125	37.49		37.49	102.92	61.63	1.00	1.00	7.14	86.01	57.34
<b>+D+0.750L</b>														
Dsgn. L =	21.00 ft	1	0.501	0.103	30.87		30.87	102.92	61.63	1.00	1.00	5.88	86.01	57.34
<b>+0.60D</b>														
Dsgn. L =	21.00 ft	1	0.107	0.022	6.62		6.62	102.92	61.63	1.00	1.00	1.26	86.01	57.34

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.7929	10.560		0.0000	0.000

**Vertical Reactions**

Load Combination	Support notation : Far left is #		Values in KIPS	
	Support 1	Support 2		
Max Upward from all Load Conditions	7.140	7.140		
Max Upward from Load Combinations	7.140	7.140		
Max Upward from Load Cases	5.040	5.040		
D Only	2.100	2.100		
+D+L	7.140	7.140		
+D+0.750L	5.880	5.880		
+0.60D	1.260	1.260		

Project Title:  
Engineer:  
Project ID:  
Project Descr:

**Steel Beam**

Project File: Brewer.ec6

LIC# : KW-06015690, Build:20.23.08.30

CROCKETT ENGINEERING CONSULTANTS

(c) ENERCALC INC 1983-2023

**DESCRIPTION:** 21' girder grid F

**Vertical Reactions**

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	5.040	5.040

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

<b>Steel Beam</b>	Project File: Brewer.ec6
LIC# : KW-06015690, Build:20.23.08.30	(c) ENERCALC INC 1983-2023

CROCKETT ENGINEERING CONSULTANTS

**DESCRIPTION:** 30' girder line G

**CODE REFERENCES**

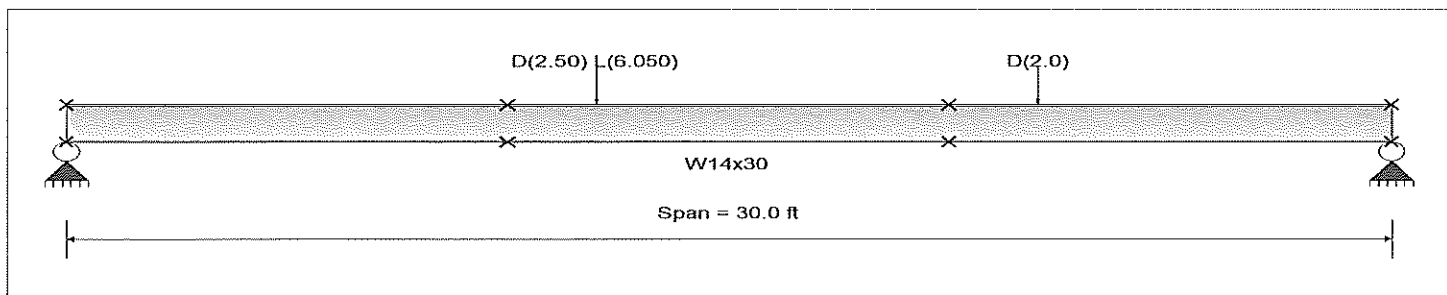
Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method Allowable Strength Design	Fy : Steel Yield : 50.0 ksi
Beam Bracing : Beam bracing is defined as a set spacing over all spans	E: Modulus : 29,000.0 ksi
Bending Axis : Major Axis Bending	

**Unbraced Lengths**

First Brace starts at 10.0 ft from Left-Most support  
 Regular spacing of lateral supports on length of beam = 10.0 ft



**Applied Loads**

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Load(s) for Span Number 1  
 Point Load : D = 2.50, L = 6.050 k @ 12.0 ft

Point Load : D = 2.0 k @ 22.0 ft

**DESIGN SUMMARY**

**Design OK**

Maximum Bending Stress Ratio =	0.639 : 1	Maximum Shear Stress Ratio =	0.076 : 1
Section used for this span	<b>W14x30</b>	Section used for this span	<b>W14x30</b>
Ma : Applied	67.960 k-ft	Va : Applied	5.663 k
Mn / Omega : Allowable	106.399 k-ft	Vn/Omega : Allowable	74.520 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
		Span # where maximum occurs	Span # 1
<b>Maximum Deflection</b>			
Max Downward Transient Deflection	0.663 in Ratio = 542	>=240.0	Span: 1 : L Only
Max Upward Transient Deflection	0 in Ratio = 0	<240.0	n/a
Max Downward Total Deflection	1.103 in Ratio = 326	>=180	Span: 1 : +D+L
Max Upward Total Deflection	0 in Ratio = 0	<180	n/a

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
<b>D Only</b>														
Dsgn. L =	9.94 ft	1	0.171	0.027	20.22		20.22	197.08	118.01	1.67	1.00	2.03	111.78	74.52
Dsgn. L =	10.03 ft	1	0.243	0.027	24.40	20.22	24.40	167.60	100.36	1.05	1.00	2.03	111.78	74.52
Dsgn. L =	10.03 ft	1	0.175	0.033	20.68		20.68	197.08	118.01	1.47	1.00	2.47	111.78	74.52
<b>+D+L</b>														
Dsgn. L =	9.94 ft	1	0.477	0.076	56.31		56.31	197.08	118.01	1.67	1.00	5.66	111.78	74.52
Dsgn. L =	10.03 ft	1	0.639	0.076	67.96	44.95	67.96	177.69	106.40	1.11	1.00	5.66	111.78	74.52
Dsgn. L =	10.03 ft	1	0.381	0.066	44.95		44.95	197.08	118.01	1.56	1.00	4.89	111.78	74.52
<b>+D+0.750L</b>														
Dsgn. L =	9.94 ft	1	0.401	0.064	47.29		47.29	197.08	118.01	1.67	1.00	4.76	111.78	74.52
Dsgn. L =	10.03 ft	1	0.540	0.064	57.07	38.88	57.07	176.57	105.73	1.10	1.00	4.76	111.78	74.52
Dsgn. L =	10.03 ft	1	0.329	0.057	38.88		38.88	197.08	118.01	1.55	1.00	4.28	111.78	74.52
<b>+0.60D</b>														
Dsgn. L =	9.94 ft	1	0.103	0.016	12.13		12.13	197.08	118.01	1.67	1.00	1.22	111.78	74.52
Dsgn. L =	10.03 ft	1	0.146	0.016	14.64	12.13	14.64	167.60	100.36	1.05	1.00	1.22	111.78	74.52

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

<b>Steel Beam</b>	Project File: Brewer.ec6
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LIC# : KW-08015690, Build:20.23.08.30      CROCKETT ENGINEERING CONSULTANTS      (c) ENERCALC INC 1983-2023

**DESCRIPTION:** 30' girder line G

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values					Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	VnxVnx/Omega	
Dsgn. L =	10.03 ft	1	0.105	0.020	12.41		12.41	197.08	118.01	1.47	1.00	1.48	111.78	74.52

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	1.1032	14.486		0.0000	0.000

**Vertical Reactions**

Load Combination	Support notation : Far left is #		Values in KIPS	
	Support 1	Support 2		
Max Upward from all Load Conditions	5.663	4.887		
Max Upward from Load Combinations	5.663	4.887		
Max Upward from Load Cases	3.630	2.467		
D Only	2.033	2.467		
+D+L	5.663	4.887		
+D+0.750L	4.756	4.282		
+0.60D	1.220	1.480		
L Only	3.630	2.420		



Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

<b>Steel Column</b>	Project File: Brewer.ec6
LIC#: KW-06015690, Build:20.23.08.30	CROCKETT ENGINEERING CONSULTANTS
(c) ENERCALC INC 1983-2023	

**DESCRIPTION:** cant. col.

**Code References**

Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combinations Used : ASCE 7-16

**General Information**

Steel Section Name : Pipe4xS	Overall Column Height	2 ft
Analysis Method : Allowable Strength	Top & Bottom Fixity	Top Free, Bottom Fixed
Steel Stress Grade	Brace condition :	
Fy : Steel Yield 46.0 ksi	Unbraced Length for buckling ABOUT X-X Axis = 2 ft, K = 2.1	
E : Elastic Bending Modulus 29,000.0 ksi	Unbraced Length for buckling ABOUT Y-Y Axis = 2 ft, K = 1.0	

**Applied Loads**

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 30.0 lbs \* Dead Load Factor  
 AXIAL LOADS . . .  
 Axial Load at 2.0 ft, Xecc = 2.250 in, D = 10.0, L = 15.0 k  
 BENDING LOADS . . .  
 Lat. Point Load at 4.0 ft creating Mx-x, W = 5.0, E = 5.0 k

**DESIGN SUMMARY**

**Bending & Shear Check Results**

<b>PASS</b> Max. Axial+Bending Stress Ratio = <b>0.8483</b> : 1 Load Combination +D+0.750L+0.5250E Location of max.above base 0.0 ft At maximum location values are . . . Pa : Axial 21.280 k Pn / Omega : Allowabl 105.508 k Ma-x : Applied -5.250 k-ft Mn-x / Omega : Allowable 12.694 k-ft Ma-y : Applied -3.984 k-ft Mn-y / Omega : Allowable 12.694 k-ft	<b>Maximum Load Reactions . .</b> Top along X-X 0.0 k Bottom along X-X 0.0 k Top along Y-Y 0.0 k Bottom along Y-Y 5.0 k  <b>Maximum Load Deflections . . .</b> Along Y-Y 0.08668 in at 2.0ft above base for load combination : W Only Along X-X 0.06084 in at 2.0ft above base for load combination : +D+L
<b>PASS</b> Maximum Shear Stress Rati <b>0.1023</b> : 1 Load Combination +D+0.70E Location of max.above base 0.0 ft At maximum location values are . . . Va : Applied 3.50 k Vn / Omega : Allowable 34.211 k	

**Load Combination Results**

Load Combination	Maximum Axial + Bending Stress Ratios				Maximum Shear Ratios					
	Stress Ratio	Status	Location	Cbx	Cby	KxLx/Ry	KyLy/Rx	Stress Ratio	Status	Location
D Only	0.195	PASS	0.00 ft	1.67	1.00	34.05	0.00	0.000	PASS	0.00 ft
+D+L	0.565	PASS	0.00 ft	1.67	1.00	34.05	0.00	0.000	PASS	0.00 ft
+D+0.750L	0.481	PASS	1.50 ft	1.67	1.00	34.05	0.00	0.000	PASS	0.00 ft
+D+0.60W	0.668	PASS	0.00 ft	1.67	1.00	34.05	0.00	0.088	PASS	0.00 ft
+D+0.750L+0.450W	0.796	PASS	0.00 ft	1.67	1.00	34.05	0.00	0.066	PASS	0.00 ft
+0.60D+0.60W	0.590	PASS	0.00 ft	1.67	1.00	34.05	0.00	0.088	PASS	0.00 ft
+D+0.70E	0.747	PASS	0.00 ft	1.67	1.00	34.05	0.00	0.102	PASS	0.00 ft
+D+0.750L+0.5250E	0.848	PASS	0.00 ft	1.67	1.00	34.05	0.00	0.077	PASS	0.00 ft
+0.60D+0.70E	0.669	PASS	0.00 ft	1.67	1.00	34.05	0.00	0.102	PASS	0.00 ft

**Maximum Reactions**

Note: Only non-zero reactions are listed.

Load Combination	Axial Reaction	X-X Axis Reaction		k	Y-Y Axis Reaction		Mx - End Moments		My - End Moments	
	@ Base	@ Base	@ Top		@ Base	@ Top	@ Base	@ Top	@ Base	@ Top
D Only	10.030									-1.875
+D+L	25.030									-4.688
+D+0.750L	21.280									-3.984
+D+0.60W	10.030				3.000			-6.000		-1.875
+D+0.750L+0.450W	21.280				2.250			-4.500		-3.984

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**Steel Column**

Project File: Brewer.ec6

LIC# : KW-06015690, Build:20.23.08.30

CROCKETT ENGINEERING CONSULTANTS

(c) ENERCALC INC 1983-2023

DESCRIPTION: cant. col.

**Maximum Reactions**

Note: Only non-zero reactions are listed.

Load Combination	Axial Reaction	X-X Axis Reaction		k	Y-Y Axis Reaction		Mx - End Moments		k-ft	My - End Moments	
	@ Base	@ Base	@ Top		@ Base	@ Top	@ Base	@ Top		@ Base	@ Top
+0.60D+0.60W	6.018				3.000		-6.000			-1.125	
+D+0.70E	10.030				3.500		-7.000			-1.875	
+D+0.750L+0.5250E	21.280				2.625		-5.250			-3.984	
+0.60D+0.70E	6.018				3.500		-7.000			-1.125	
L Only	15.000									-2.813	
W Only					5.000		-10.000				
E Only					5.000		-10.000				

**Extreme Reactions**

Item	Extreme Value	Axial Reaction	X-X Axis Reaction		k	Y-Y Axis Reaction		Mx - End Moments		k-ft	My - End Moments	
		@ Base	@ Base	@ Top		@ Base	@ Top	@ Base	@ Top		@ Base	@ Top
Axial @ Base	Maximum	25.030										-4.688
"	Minimum					5.000		-10.000				
Reaction, X-X Axis Base	Maximum	10.030										-1.875
"	Minimum	10.030										-1.875
Reaction, Y-Y Axis Base	Maximum					5.000		-10.000				
"	Minimum	10.030						-1.875				
Reaction, X-X Axis Top	Maximum	10.030										-1.875
"	Minimum	10.030										-1.875
Reaction, Y-Y Axis Top	Maximum	10.030										-1.875
"	Minimum	10.030										-1.875
Moment, X-X Axis Base	Maximum	10.030										-1.875
"	Minimum			-10.000		5.000		-10.000				
Moment, Y-Y Axis Base	Maximum					5.000						
"	Minimum	25.030										-4.688
Moment, X-X Axis Top	Maximum	10.030										-1.875
"	Minimum	10.030										-1.875
Moment, Y-Y Axis Top	Maximum	10.030										-1.875
"	Minimum	10.030										-1.875

**Maximum Deflections for Load Combinations**

Load Combination	Max. Deflection in X dir	Distance	Max. Deflection in Y dir	Distance
D Only	0.0243 in	2.000 ft	0.000 in	0.000 ft
+D+L	0.0608 in	2.000 ft	0.000 in	0.000 ft
+D+0.750L	0.0517 in	2.000 ft	0.000 in	0.000 ft
+D+0.60W	0.0243 in	2.000 ft	0.052 in	2.000 ft
+D+0.750L+0.450W	0.0517 in	2.000 ft	0.039 in	2.000 ft
+0.60D+0.60W	0.0146 in	2.000 ft	0.052 in	2.000 ft
+D+0.70E	0.0243 in	2.000 ft	0.061 in	2.000 ft
+D+0.750L+0.5250E	0.0517 in	2.000 ft	0.046 in	2.000 ft
+0.60D+0.70E	0.0146 in	2.000 ft	0.061 in	2.000 ft
L Only	0.0365 in	2.000 ft	0.000 in	0.000 ft
W Only	0.0000 in	0.000 ft	0.087 in	2.000 ft
E Only	0.0000 in	0.000 ft	0.086 in	1.987 ft

Steel Section Properties : Pipe4xS

Steel Section Properties : Pipe4xS

Project Title:  
Engineer:  
Project ID:  
Project Descr:

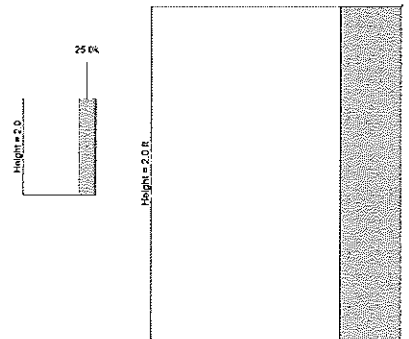
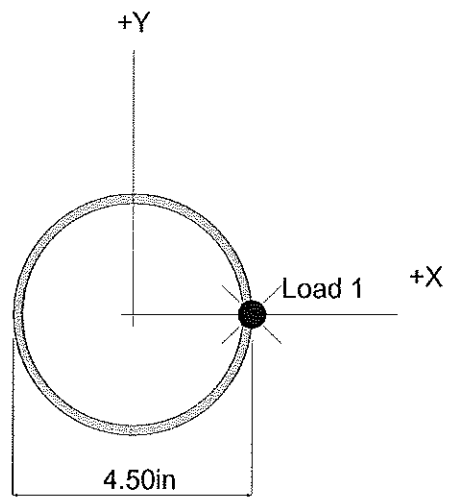
**Steel Column** Project File: Brewer.ec6

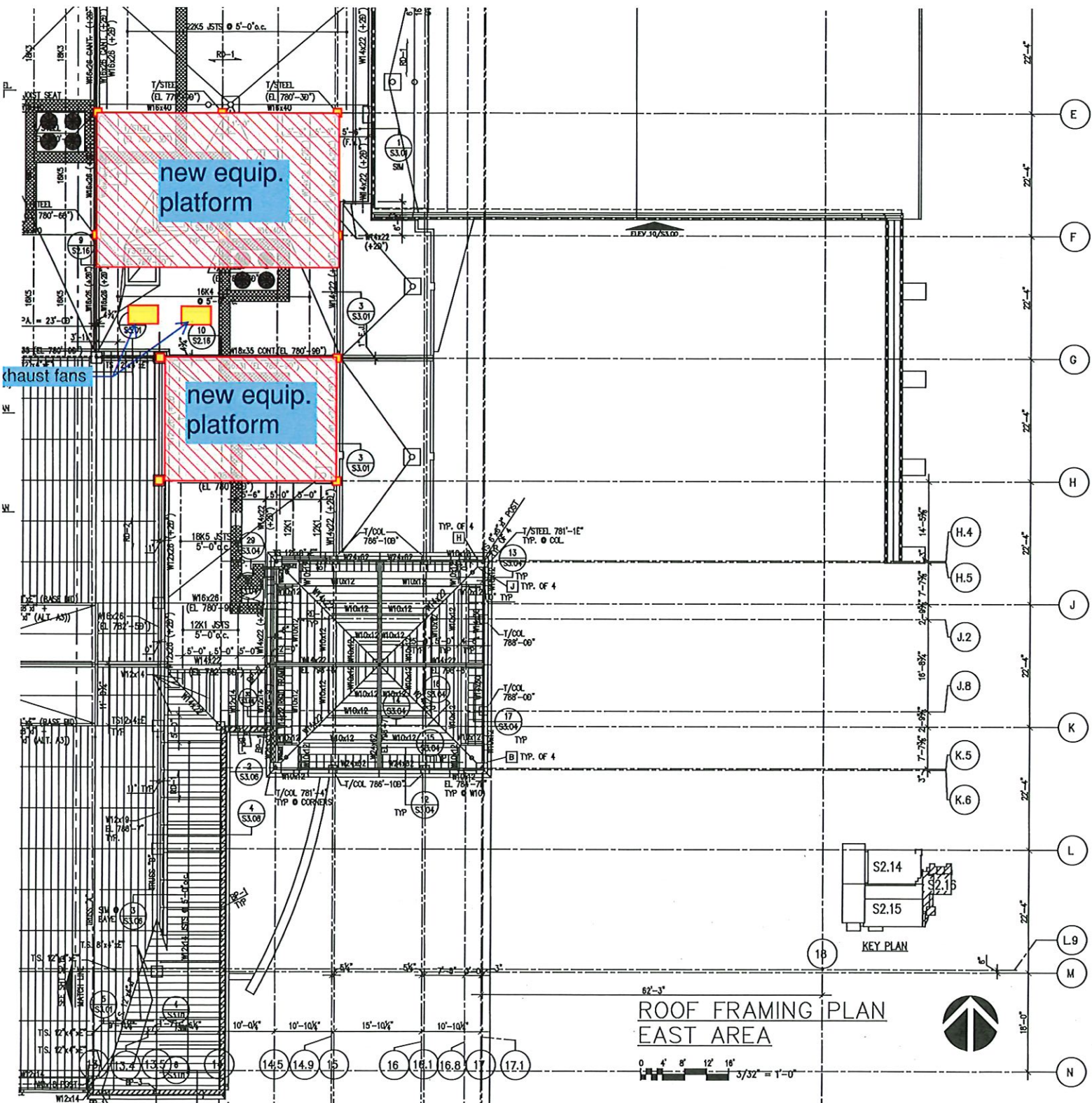
LIC# : KW-06015690, Build:20.23.08.30 CROCKETT ENGINEERING CONSULTANTS (c) ENERCALC INC 1983-2023

**DESCRIPTION:** cant. col.

Depth	=	4.500 in	I xx	=	9.12 in^4	J	=	18.200 in^4
			S xx	=	4.05 in^3			
Diameter	=	4.500 in	R xx	=	1.480 in			
Wall Thick	=	0.338 in	Zx	=	5.530 in^3			
Area	=	4.140 in^2	I yy	=	9.120 in^4			
Weight	=	15.000 plf	S yy	=	4.050 in^3			
			R yy	=	1.480 in			
Ycg	=	0.000 in						

**Sketches**





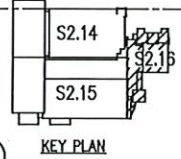
new equip. platform

haust fans

new equip. platform

ROOF FRAMING PLAN  
EAST AREA

0 4' 8' 12' 16'  
3/32" = 1'-0"



KEY PLAN

E

F

G

H

J

K

L

L9

M

N

H.4

H.5

J.2

J.8

K.5

K.6

14.5

14.9

15

16

16.1

16.8

17

17.1

Look @ Ex.  
Columns & Figs  
For New Loads

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C O L U M N										S C H E D U									
COLUMN NUMBERS	A-16.8 A1-16	A2-13.3 A2-14.7	B-13.3 B-13.7 C-14.7 C.7-13.3 C.7-14.7	C.8-1.3 C.8-1.3	D-1.3 F-1.3 F-1.3	D-2 F-1.5	D-3 D-4 D-5 D-6 D-7 D-8 D-9	D-13	E-2 F-2 E-4 F-4 E-11 F-11	E-5 E-6 E-7 E-8 E-9 E-10 E-11	F-5 F-6 F-7 F-8 F-9 F-10 F-11	G-1.5	F-16 H-16	G-3 G-4 G-5	H-1.5 H-1.5 H-1.5 H-1.5				
ROOF (VARIES)																			
DETAIL																			
COLUMN SIZE	3/SI.01 12"x12"	2/SI.01 18"x18"	2/SI.01 18"x18"	4/SI.01 12"x18"	4/SI.01 12"x18"	2/SI.01 18"x18"	1/SI.01 20"x20"	4/SI.01 20"x20"	2/SI.01 18"x18"	1/SI.01 20"x20"	2/SI.01 18"x18"	1/SI.01 24"x24"	1/SI.01 24"x24"	1/SI.01 24"x24"	1/SI.01 24"x24"				
COLUMN VERTS	4-#6	8-#6	8-#6	8-#6	8-#6	8-#6	12-#8	8-#6 EA. COL	8-#6	12-#8	12-#8	12-#8	12-#8	12-#8	12-#8				
COLUMN TIES	#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	3-#3 @ 14"	2-#3 @ 8"	2-#3 @ 12"	3-#3 @ 14"	2-#3 @ 12"	3-#3 @ 14"	3-#3 @ 14"	3-#3 @ 14"	3-#3 @ 14"				
2nd FLOOR																			
DETAIL																			
COLUMN SIZE	3/SI.01 12"x12"	2/SI.01 18"x18"	2/SI.01 18"x18"	4/SI.01 12"x18"	4/SI.01 12"x18"	2/SI.01 18"x18"	1/SI.01 20"x20"	4/SI.01 20"x20"	2/SI.01 18"x18"	1/SI.01 20"x20"	2/SI.01 18"x18"	1/SI.01 24"x24"	1/SI.01 24"x24"	1/SI.01 24"x24"	1/SI.01 24"x24"				
COLUMN VERTS	4-#6	8-#6	8-#6	8-#6	8-#6	8-#6	12-#8	8-#6 EA. COL	8-#6	12-#8	12-#8	12-#8	12-#8	12-#8	12-#8				
COLUMN TIES	#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	3-#3 @ 14"	2-#3 @ 8"	2-#3 @ 12"	3-#3 @ 14"	2-#3 @ 12"	3-#3 @ 14"	3-#3 @ 14"	3-#3 @ 14"	3-#3 @ 14"				
MEZZANINE																			
DETAIL																			
COLUMN SIZE	3/SI.01 12"x12"	2/SI.01 18"x18"	2/SI.01 18"x18"	4/SI.01 12"x18"	4/SI.01 12"x18"	2/SI.01 18"x18"	1/SI.01 20"x20"	4/SI.01 20"x20"	2/SI.01 18"x18"	1/SI.01 20"x20"	2/SI.01 18"x18"	1/SI.01 24"x24"	1/SI.01 24"x24"	1/SI.01 24"x24"	1/SI.01 24"x24"				
COLUMN VERTS	4-#6	8-#6	8-#6	8-#6	8-#6	8-#6	12-#8	8-#6 EA. COL	8-#6	12-#8	12-#8	12-#8	12-#8	12-#8	12-#8				
COLUMN TIES	#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	2-#3 @ 12"	3-#3 @ 14"	2-#3 @ 8"	2-#3 @ 12"	3-#3 @ 14"	2-#3 @ 12"	3-#3 @ 14"	3-#3 @ 14"	3-#3 @ 14"	3-#3 @ 14"				
MECHANICAL																			
DETAIL																			
COLUMN SIZE																			
COLUMN VERTS																			
COLUMN TIES																			
EL. TOP OF FPG.	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN				
DOWELS TO COLUMN	4-#6	8-#7	8-#7	8-#6	8-#6	8-#6	12-#8	8-#6 EA. COL	8-#7	12-#8	12-#8	12-#8	8-#6	12-#8	12-#8				
SIZE (LxWxDPTH)	3'-0"x3'-0"x12"	6'-5"x6'-5"x20"	8'-0"x8'-0"x24"	4'-0"x4'-0"x12"	SEE 9/SI.05	6'-5"x6'-5"x20"	14-#6	8'-0"x8'-0"x18"	8'-0"x8'-0"x24"	6'-5"x6'-5"x20"	14-#6	8'-0"x8'-0"x18"	4'-0"x4'-0"x12"	8'-0"x8'-0"x28"	8'-6"x8'-6"x28"				
REMARK: (B EA WAY BOT)	12-#4	14-#6	22-#6	8-#6 TRANS D-1.3	SEE 10/SI.05 D-1.3	14-#6	14-#6	14-#6	22-#6	14-#6	14-#6	14-#6	18-#4	28-#6	8-#6 L 11-#6				

	H-13.5 J-13.5 K-13.5 L-13.5	H-14 J-14 H-15	E-3 F-3	E-13 F-13 G-15	G-13.5	H.4-14.9 J.2-17.1 J.8-17.1 K.6-14.9 K.6-16.1	H.5-14.5 H.5-17 K.5-14.5 K.5-17
	1/S1.01	2/S1.01	5/S1.01	4/S1.01	4/S1.01	2/S1.01	1/S1.01
	24"x24"	18"x18"	25"x18"	2- 8D"x18"	2- 11D"x24"	18"x18"	24"x24"
	12- #8	8- #8	10- #7	8- #8 EA. COL.	8- #9 EA. COL.	8- #9	12- #10
	3- #3 @ 14"	3- #3 @ 14"	3- #3 @ 14"	2- #3 @ 8" EA. COL.	2- #3 @ 10" EA. COL.	2- #3 @ 12"	3- #3 @ 12"
	766'-6"	766'-6"	766'-6"	766'-6"	766'-6"	766'-6"	766'-6"
	1/S1.01	2/S1.01	5/S1.01	4/S1.01	4/S1.01	2/S1.01	1/S1.01
	24"x24"	18"x18"	25"x18"	2- 8D"x18"	2- 11D"x24"	18"x18"	24"x24"
L	12- #8	8- #8	10- #7	8- #8 EA. COL.	8- #9 EA. COL.	8- #9	12- #10
	3- #3 @ 14"	3- #3 @ 14"	3- #3 @ 14"	2- #3 @ 8" EA. COL.	2- #3 @ 10" EA. COL.	2- #3 @ 12"	3- #3 @ 12"
	751'-5"	751'-5"	751'-5"	751'-5"	751'-5"	751'-5"	751'-5"
	1/S1.01	2/S1.01	5/S1.01	4/S1.01	4/S1.01	2/S1.01	1/S1.01
	24"x24"	18"x18"	25"x18"	2- 8D"x18"	2- 11D"x24"	18"x18"	24"x24"
L	12- #8	8- #8	10- #8	8- #8 EA. COL.	8- #9 EA. COL.	8- #9	12- #10
	3- #3 @ 14"	3- #3 @ 14"	3- #3 @ 14"	2- #3 @ 8" EA. COL.	2- #3 @ 10" EA. COL.	2- #3 @ 12"	3- #3 @ 12"
	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN	PER PLAN
L	12- #8	8- #8	10- #8	8- #8 EA. COL.	8- #9 EA. COL.	8- #9	12- #10
2"	5'-0"x5'-0"x16"	7'-0"x7'-0"x24"	8'-0"x8'-0"x24"	8'-0"x8'-0"x24"	7'-0"x7'-0"x24"	6'-0"x6'-0"x18"	6'-0"x6'-0"x18"
	12- #5	18- #6	22- #6	22- #6	18- #6	14- #6	14- #6

Look @ worstcase Ftg

8'  $\phi$  + 2' Deep w/ 5 ksf Brg

8' x 8' x 5 ksf = 320k capacity of Ex. Ftg

New Loading < 16k thus OK By Ex. Bldg Code standards.

Same For Low



Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**DESCRIPTION:** existing concrete lower level column evaluation

**Code References**

Calculations per ACI 318-19, IBC 2021, ASCE 7-16  
 Load Combinations Used : ASCE 7-16

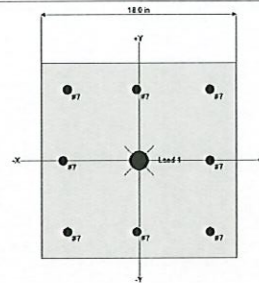
**General Information**

fc : Concrete 28 day strength =	4.0 ksi	Overall Column Height =	15.0 ft
E =	3,122.0 ksi	End Fixity	Top & Bottom Pinned
Density =	150.0 pcf	Brace condition for deflection (buckling) along column	
$\beta$ =	0.850	X-X (width) axis :	
fy - Main Rebar =	60.0 ksi	Unbraced Length for buckling ABOUT X-X Axis =	15.0 ft, K = 1.0
E - Main Rebar =	29,000.0 ksi	Y-Y (depth) axis :	
Allow. Reinforcing Limits	ASTM A615 Bars Used	Unbraced Length for buckling ABOUT Y-Y Axis =	15.0 ft, K = 1.0
Min. Reinf. =	1.0 %		
Max. Reinf. =	8.0 %		
Seismic Design Category =	C		

**Column Cross Section**

Column Dimensions : 18.0in Square Column, Column Edge to Rebar Edge Cover = 2.0in

Column Reinforcing : 4 - #7 bars @ corners,, 1 - #7 bars top & bottom between corner bars, 1 - #7 bars left & right between corner



**Applied Loads**

Entered loads are factored per load combinations specified by user.

Column self weight included : 5,062.50 lbs \* Dead Load Factor

AXIAL LOADS . . .

existing loadings: Axial Load at 15.0 ft above base, D = 150.0, LR = 12.0, L = 300.0 k

*New Loading less than 5% of dead loading thus OK*

**DESIGN SUMMARY**

Load Combination	+1.20D+0.50LR+1.60L	<b>Maximum SERVICE Load Reactions .</b>	
Location of max. above base	14.899 ft	Top along Y-Y	0.0 k
		Bottom along Y-Y	0.0 k
		Top along X-X	0.0 k
		Bottom along X-X	0.0 k
<b>Maximum Stress Ratio</b>	<b>0.946 : 1</b>	<b>Maximum SERVICE Load Deflections . .</b>	
Ratio = $(Pu^2 + Mu^2)^{.5} / (\Phi Pn^2 + \Phi Mn^2)^{.5}$		Along Y-Y	0.0 in at 0.0 ft above base
Pu = 672.08 k	$\Phi * Pn = 714.11 k$	for load combination :	
Mu-x = 0.0 k-ft	$\Phi * Mn-x = 0.0 k-ft$	Along X-X	0.0 in at 0.0 ft above base
Mu-y = 67.307 k-ft	$\Phi * Mn-y = 69.541 k-ft$	for load combination :	
Mu Angle = 90.0 deg	$\Phi = 0.650$		
Vu at Angle = 67.307 k-ft	$\Phi Mn \text{ at Angle} = 70.837 k-ft$		

Pn & Mn values located at Pu-Mu vector intersection with capacity curve

**Column Capacities . .**

Pnmax : Nominal Max. Compressive Axial Capacity	1,373.28 k
Pnmin : Nominal Min. Tension Axial Capacity	k
$\Phi Pn$ , max : Usable Compressive Axial Capacity	714.11 k
$\Phi Pn$ , min : Usable Tension Axial Capacity	k

**General Section Information**

$\beta$ =	0.850	$\theta =$	0.80
$\rho$ : % Reinforcing	1.481 %	Rebar % Ok	
Reinforcing Area	4.80 in <sup>2</sup>		
Concrete Area	324.0 in <sup>2</sup>		

**Governing Load Combination Results**

Governing Factored Load Combination	Moment		Dist. from base		Axial Load		Bending Analysis k-ft						Utilization Ratio
	X-X	Y-Y	ft	ft	Pu	$\Phi * Pn$	$\delta x$	$\delta x * Mu_x$	$\delta y$	$\delta y * Mu_y$	Alpha (deg)	$\delta Mu$	
+1.40D	Actual	M2,min	14.90	217.09	714.11	1.000	1.000	20.62	90.000	20.62	68.27	0.303	

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**DESCRIPTION:** existing concrete lower level column evaluation

**Governing Load Combination Results**

Governing Factored Load Combination	Moment		Dist. from base ft	Axial Load k			Bending Analysis k-ft					Utilization		
	X-X	Y-Y		Pu	$\phi$	* Pn	$\delta x$	$\delta x$ * Mux	$\delta y$	$\delta y$ * Muy	Alpha (deg)	$\delta$ Mu	$\phi$ Mn	Ratio
+1.40D	M2,min	Actual	14.90	217.09	714.11	1.000	20.62	1.000			0.000	20.62	68.38	0.303
+1.20D+0.50Lr+1.60L	Actual	M2,min	14.90	672.08	714.11	1.054		1.054	67.31	90.000	67.31	70.84	0.946	
+1.20D+0.50Lr+1.60L	M2,min	Actual	14.90	672.08	714.11	1.054	67.31	1.054		0.000	67.31	70.89	0.946	
+1.20D+1.60L	Actual	M2,min	14.90	666.08	714.11	1.047		1.047	66.26	90.000	66.26	70.84	0.934	
+1.20D+1.60L	M2,min	Actual	14.90	666.08	714.11	1.047	66.26	1.047		0.000	66.26	70.89	0.934	
+1.20D+1.60Lr+L	Actual	M2,min	14.90	505.28	714.11	1.000		1.000	48.00	90.000	48.00	68.27	0.705	
+1.20D+1.60Lr+L	M2,min	Actual	14.90	505.28	714.11	1.000	48.00	1.000		0.000	48.00	68.38	0.704	
+1.20D+1.60Lr	Actual	M2,min	14.90	205.28	714.11	1.000		1.000	19.50	90.000	19.50	68.27	0.286	
+1.20D+1.60Lr	M2,min	Actual	14.90	205.28	714.11	1.000	19.50	1.000		0.000	19.50	68.38	0.286	
+1.20D+L	Actual	M2,min	14.90	486.08	714.11	1.000		1.000	46.18	90.000	46.18	68.27	0.678	
+1.20D+L	M2,min	Actual	14.90	486.08	714.11	1.000	46.18	1.000		0.000	46.18	68.38	0.678	
+1.20D	Actual	M2,min	14.90	186.08	714.11	1.000		1.000	17.68	90.000	17.68	68.27	0.260	
+1.20D	M2,min	Actual	14.90	186.08	714.11	1.000	17.68	1.000		0.000	17.68	68.38	0.259	
+1.20D+0.50Lr+L	Actual	M2,min	14.90	492.08	714.11	1.000		1.000	46.75	90.000	46.75	68.27	0.687	
+1.20D+0.50Lr+L	M2,min	Actual	14.90	492.08	714.11	1.000	46.75	1.000		0.000	46.75	68.38	0.686	
+0.90D	Actual	M2,min	14.90	139.56	714.11	1.000		1.000	13.26	90.000	13.26	68.27	0.195	
+0.90D	M2,min	Actual	14.90	139.56	714.11	1.000	13.26	1.000		0.000	13.26	68.38	0.195	

**Maximum Reactions**

Note: Only non-zero reactions are listed.

Load Combination	X-X Axis Reaction k		Y-Y Axis Reaction k		Axial Reaction k	Mx - End Moments k-ft		My - End Moments k-ft	
	@ Base	@ Top	@ Base	@ Top		@ Base	@ Top	@ Base	@ Top
D Only					155.063				
+D+L					455.063				
+D+Lr					167.063				
+D+0.750Lr+0.750L					389.063				
+D+0.750L					380.063				
+0.60D					93.038				
Lr Only					12.000				
L Only					300.000				

**Maximum Moment Reactions**

Note: Only non-zero reactions are listed.

Load Combination	Moment About X-X Axis k-ft		Moment About Y-Y Axis k-ft	
	@ Base	@ Top	@ Base	@ Top
D Only				
+D+L				
+D+Lr				
+D+0.750Lr+0.750L				
+D+0.750L				
+0.60D				
Lr Only				
L Only				

**Maximum Deflections for Load Combinations**

Load Combination	Max. X-X Deflection		Max. Y-Y Deflection	
	Distance	Distance	Distance	Distance
D Only	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+L	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+Lr	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+0.750Lr+0.750L	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+0.750L	0.0000 in	0.000 ft	0.000 in	0.000 ft
+0.60D	0.0000 in	0.000 ft	0.000 in	0.000 ft
Lr Only	0.0000 in	0.000 ft	0.000 in	0.000 ft
L Only	0.0000 in	0.000 ft	0.000 in	0.000 ft

Project Title:  
Engineer:  
Project ID:  
Project Descr:

## Concrete Column

Project File: Brewer.ec6

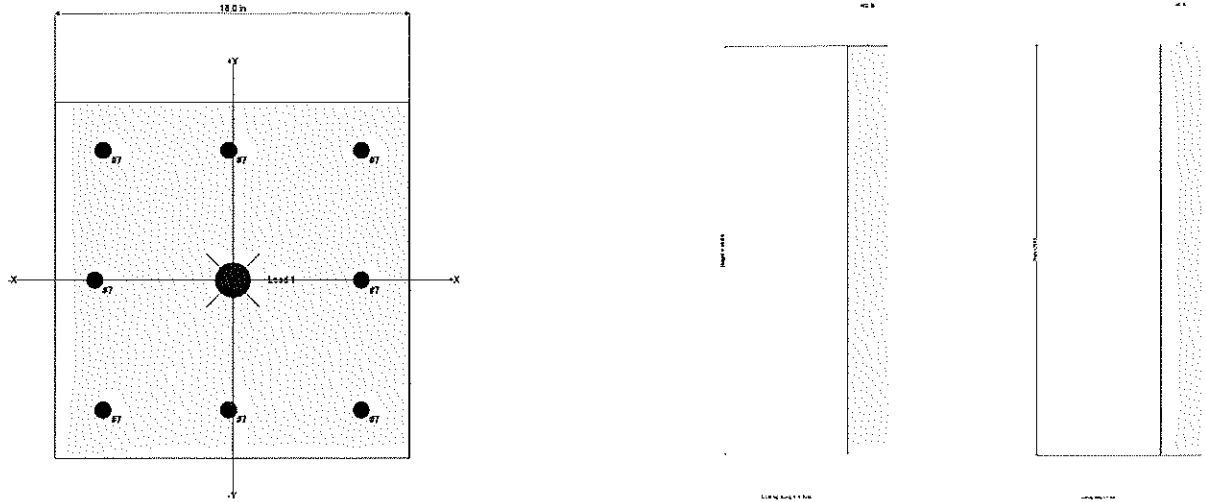
LIC# : KW-06015690, Build:20.23.08.30

CROCKETT ENGINEERING CONSULTANTS

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DESCRIPTION: existing concrete lower level column evaluation

### Sketches



### Interaction Diagrams

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**DESCRIPTION:** existing concrete roof column evaluation

worst case roof col. for New Loading

**Code References**

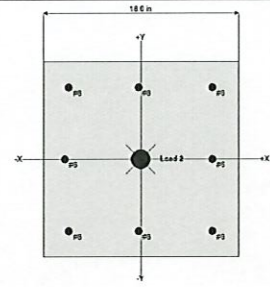
Calculations per ACI 318-19, IBC 2021, ASCE 7-16  
 Load Combinations Used : ASCE 7-16

**General Information**

f <sub>c</sub> : Concrete 28 day strength = 4.0 ksi E = 3,122.0 ksi Density = 150.0 pcf β = 0.850 f <sub>y</sub> - Main Rebar = 60.0 ksi E - Main Rebar = 29,000.0 ksi Allow. Reinforcing Limits <i>ASTM A615 Bars Used</i> Min. Reinf. = 1.0 % Max. Reinf. = 8.0 % Seismic Design Category = C	Overall Column Height = 14.0 ft End Fixity Top & Bottom Pinned Brace condition for deflection (buckling) along column X-X (width) axis : Unbraced Length for buckling ABOUT X-X Axis = 14.0 ft, K = 1.0 Y-Y (depth) axis : Unbraced Length for buckling ABOUT Y-Y Axis = 14.0 ft, K = 1.0
--	---

**Column Cross Section**

Column Dimensions : 18.0in Square Column, Column Edge to Rebar Edge Cover = 2.0in  
 Column Reinforcing : 4 - #6 bars @ corners, 1 - #6 bars top & bottom between corner bars, 1 - #6 bars left & right between corner



**Applied Loads**

Entered loads are factored per load combinations specified by user.

Column self weight included : 4,725.0 lbs \* Dead Load Factor  
 AXIAL LOADS . . .  
 existing loadings: Axial Load at 14.0 ft above base, D = 12.0, LR = 12.0 k  
 new loading: Axial Load at 14.0 ft above base, D = 15.0, L = 15.0 k

checks easily

**DESIGN SUMMARY**

Load Combination +1.20D+1.60Lr+L Location of max. above base 13.906 ft <b>Maximum Stress Ratio</b> Ratio = $(P_u^2 + M_u^2)^{.5} / (\Phi P_n^2 + \Phi M_n^2)^{.5} \cdot .5$ P <sub>u</sub> = 72.270 k      ϕ * P <sub>n</sub> = 676.43 k M <sub>u-x</sub> = 0.0 k-ft      ϕ * M <sub>n-x</sub> = 0.0 k-ft M <sub>u-y</sub> = 6.866 k-ft      ϕ * M <sub>n-y</sub> = 63.106 k-ft Mu Angle = 90.0 deg      ϕ = 0.650 Mu at Angle = 6.866 k-ft      ϕ M <sub>n</sub> at Angle = 64.289 k-ft <i>P<sub>n</sub> &amp; M<sub>n</sub> values located at P<sub>u</sub>-M<sub>u</sub> vector intersection with capacity curve</i>	<b>Maximum SERVICE Load Reactions .</b> Top along Y-Y 0.0 k      Bottom along Y-Y 0.0 k Top along X-X 0.0 k      Bottom along X-X 0.0 k <b>Maximum SERVICE Load Deflections . .</b> Along Y-Y 0.0 in at 0.0 ft above base for load combination : Along X-X 0.0 in at 0.0 ft above base for load combination : <b>General Section Informatio</b> ρ : % Reinforcing 1.086 % Rebar % Ok Reinforcing Area 3.520 in <sup>2</sup> Concrete Area 324.0 in <sup>2</sup> β = 0.850      θ = 0.80
--	---

**Column Capacities . .**

P <sub>n</sub> max : Nominal Max. Compressive Axial Capacity	1,300.83 k
P <sub>n</sub> min : Nominal Min. Tension Axial Capacity	k
ϕ P <sub>n</sub> , max : Usable Compressive Axial Capacity	676.43 k
ϕ P <sub>n</sub> , min : Usable Tension Axial Capacity	k

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**Concrete Column**

Project File: Brewer.ec6

LIC#: KW-06015690, Build:20.23.08.30

CROCKETT ENGINEERING CONSULTANTS

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**DESCRIPTION:** existing concrete roof column evaluation

**Governing Load Combination Results**

Governing Factored Load Combination	Moment		Dist. from base ft	Axial Load k			Bending Analysis k-ft					Utilization	
	X-X	Y-Y		Pu	$\phi$	*Pn	$\delta x$	$\delta x$ * Mux	$\delta y$	$\delta y$ * Muy	Alpha (deg)	$\delta$ Mu	$\phi$ Mn
+1.40D	Actual M2,min		13.91	44.42	676.43	1.000		1.000	4.22	90.000	4.22	64.29	0.066
+1.40D	M2,min Actual		13.91	44.42	676.43	1.000	4.22	1.000		0.000	4.22	64.30	0.066
+1.20D+0.50Lr+1.60L	Actual M2,min		13.91	68.07	676.43	1.000		1.000	6.47	90.000	6.47	64.29	0.101
+1.20D+0.50Lr+1.60L	M2,min Actual		13.91	68.07	676.43	1.000	6.47	1.000		0.000	6.47	64.30	0.101
+1.20D+1.60L	Actual M2,min		13.91	62.07	676.43	1.000		1.000	5.90	90.000	5.90	64.29	0.092
+1.20D+1.60L	M2,min Actual		13.91	62.07	676.43	1.000	5.90	1.000		0.000	5.90	64.30	0.092
+1.20D+1.60Lr+L	Actual M2,min		13.91	72.27	676.43	1.000		1.000	6.87	90.000	6.87	64.29	0.107
+1.20D+1.60Lr+L	M2,min Actual		13.91	72.27	676.43	1.000	6.87	1.000		0.000	6.87	64.30	0.107
+1.20D+1.60Lr	Actual M2,min		13.91	57.27	676.43	1.000		1.000	5.44	90.000	5.44	64.29	0.085
+1.20D+1.60Lr	M2,min Actual		13.91	57.27	676.43	1.000	5.44	1.000		0.000	5.44	64.30	0.085
+1.20D+L	Actual M2,min		13.91	53.07	676.43	1.000		1.000	5.04	90.000	5.04	64.29	0.078
+1.20D+L	M2,min Actual		13.91	53.07	676.43	1.000	5.04	1.000		0.000	5.04	64.30	0.078
+1.20D	Actual M2,min		13.91	38.07	676.43	1.000		1.000	3.62	90.000	3.62	64.29	0.056
+1.20D	M2,min Actual		13.91	38.07	676.43	1.000	3.62	1.000		0.000	3.62	64.30	0.056
+1.20D+0.50Lr+L	Actual M2,min		13.91	59.07	676.43	1.000		1.000	5.61	90.000	5.61	64.29	0.087
+1.20D+0.50Lr+L	M2,min Actual		13.91	59.07	676.43	1.000	5.61	1.000		0.000	5.61	64.30	0.087
+0.90D	Actual M2,min		13.91	28.55	676.43	1.000		1.000	2.71	90.000	2.71	64.29	0.042
+0.90D	M2,min Actual		13.91	28.55	676.43	1.000	2.71	1.000		0.000	2.71	64.30	0.042

**Maximum Reactions**

Note: Only non-zero reactions are listed.

Load Combination	X-X Axis Reaction		k	Y-Y Axis Reaction		Axial Reaction @ Base	Mx - End Moments k-ft		My - End Moments	
	@ Base	@ Top		@ Base	@ Top		@ Base	@ Top	@ Base	@ Top
D Only						31.725				
+D+L						46.725				
+D+Lr						43.725				
+D+0.750Lr+0.750L						51.975				
+D+0.750L						42.975				
+0.60D						19.035				
Lr Only						12.000				
L Only						15.000				

**Maximum Moment Reactions**

Note: Only non-zero reactions are listed.

Load Combination	Moment About X-X Axis		k-ft	Moment About Y-Y Axis		k-ft
	@ Base	@ Top		@ Base	@ Top	
D Only						
+D+L						
+D+Lr						
+D+0.750Lr+0.750L						
+D+0.750L						
+0.60D						
Lr Only						
L Only						

**Maximum Deflections for Load Combinations**

Load Combination	Max. X-X Deflection		Distance	Max. Y-Y Deflection		Distance
D Only	0.0000	in	0.000	0.000	in	0.000
+D+L	0.0000	in	0.000	0.000	in	0.000
+D+Lr	0.0000	in	0.000	0.000	in	0.000
+D+0.750Lr+0.750L	0.0000	in	0.000	0.000	in	0.000
+D+0.750L	0.0000	in	0.000	0.000	in	0.000
+0.60D	0.0000	in	0.000	0.000	in	0.000
Lr Only	0.0000	in	0.000	0.000	in	0.000
L Only	0.0000	in	0.000	0.000	in	0.000

Project Title:  
Engineer:  
Project ID:  
Project Descr:

**Concrete Column**

Project File: Brewer.ec6

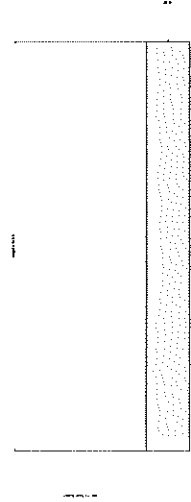
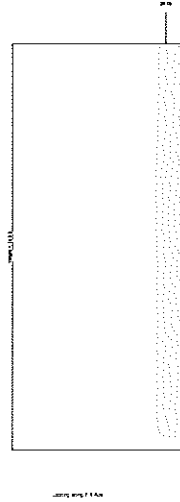
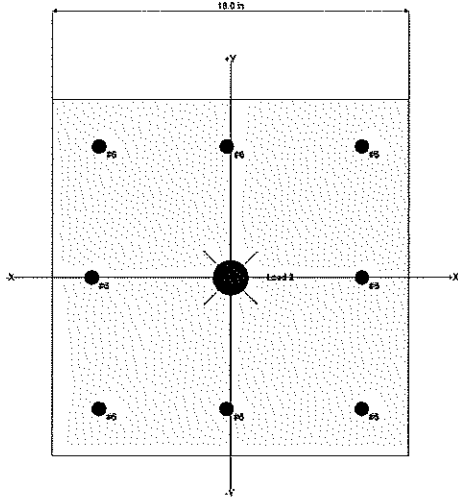
LIC# : KW-06015690, Build:20.23.08.30

CROCKETT ENGINEERING CONSULTANTS

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**DESCRIPTION:** existing concrete roof column evaluation

**Sketches**



**Interaction Diagrams**

Screen Wall Cales

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**Crockett Engineering**

1000 W Nifong Blvd  
Columbia Missouri 65203  
573-447-0292

JOB TITLE Brewer Gym

JOB NO. \_\_\_\_\_ SHEET NO. \_\_\_\_\_  
CALCULATED BY \_\_\_\_\_ DATE \_\_\_\_\_  
CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

**Wind Loads - MWFRS  $h \leq 60'$**  (Low-rise Buildings) except for open buildings

$K_z = K_h$  (case 1) = 0.77  
Base pressure (q<sub>h</sub>) = 22.6 psf  
GC<sub>pi</sub> = +/-0.18

Edge Strip (a) = 16.8 ft  
End Zone (2a) = 33.6 ft  
Zone 2 length = 105.0 ft

**Wind Pressure Coefficients**

Surface	CASE A			CASE B		
	GC <sub>pf</sub>	$\theta = 1.2 \text{ deg}$ w/-GC <sub>pi</sub>	w/+GC <sub>pi</sub>	GC <sub>pf</sub>	w/-GC <sub>pi</sub>	w/+GC <sub>pi</sub>
1	0.40	0.58	0.22	-0.45	-0.27	-0.63
2	-0.69	-0.51	-0.87	-0.69	-0.51	-0.87
3	-0.37	-0.19	-0.55	-0.37	-0.19	-0.55
4	-0.29	-0.11	-0.47	-0.45	-0.27	-0.63
5				0.40	0.58	0.22
6				-0.29	-0.11	-0.47
1E	0.61	0.79	0.43	-0.48	-0.30	-0.66
2E	-1.07	-0.89	-1.25	-1.07	-0.89	-1.25
3E	-0.53	-0.35	-0.71	-0.53	-0.35	-0.71
4E	-0.43	-0.25	-0.61	-0.48	-0.30	-0.66
5E				0.61	0.79	0.43
6E				-0.43	-0.25	-0.61

**Ultimate Wind Surface Pressures (psf)**

1	13.1	5.0	-6.1	-14.2
2	-11.5	-19.6	-11.5	-19.6
3	-4.3	-12.4	-4.3	-12.4
4	-2.5	-10.6	-6.1	-14.2
5			13.1	5.0
6			-2.5	-10.6
1E	17.8	9.7	-6.8	-14.9
2E	-20.1	-28.2	-20.1	-28.2
3E	-7.9	-16.0	-7.9	-16.0
4E	-5.6	-13.8	-6.8	-14.9
5E			17.8	9.7
6E			-5.6	-13.8

**Parapet**

Windward parapet = 26.6 psf (GC<sub>pn</sub> = +1.5)  
Leeward parapet = -17.7 psf (GC<sub>pn</sub> = -1.0)

Windward roof overhangs = 15.8 psf (upward) add to windward roof pressure

**Horizontal MWFRS Simple Diaphragm Pressures (psf)**

**Transverse direction (normal to L)**

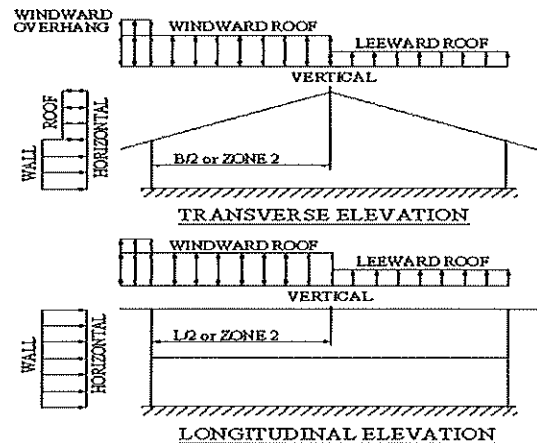
Interior Zone: Wall 15.6 psf  
Roof -7.2 psf \*\*  
End Zone: Wall 23.5 psf  
Roof -12.2 psf \*\*

**Longitudinal direction (parallel to L)**

Interior Zone: Wall 15.6 psf  
End Zone: Wall 23.5 psf

\*\* NOTE: Total horiz force shall not be less than that determined by neglecting roof forces (except for MWFRS moment frames).

The code requires the MWFRS be designed for a min ultimate force of 16 psf multiplied by the wall area plus an 8 psf force applied to the vertical projection of the roof.

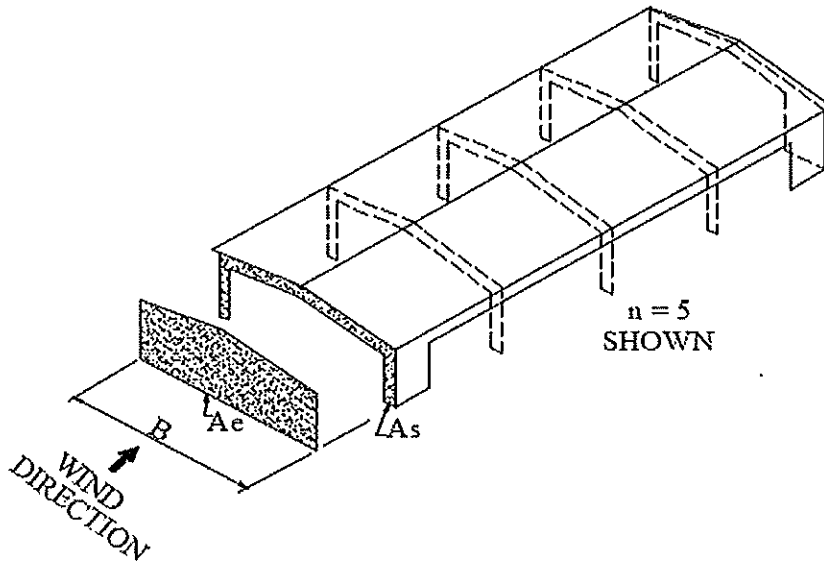




**Wind Loads - h≤60' Longitudinal Direction MWFRS On Open or Partially Enclosed Buildings with Transverse Frames and Pitched Roofs**

Base pressure (qh) = 22.6 psf  
GCpi = +/-0.18 Enclosed bldg, procdure doesn't apply  
Roof Angle (θ) = 1.2 deg

ASCE 7-16 procedure

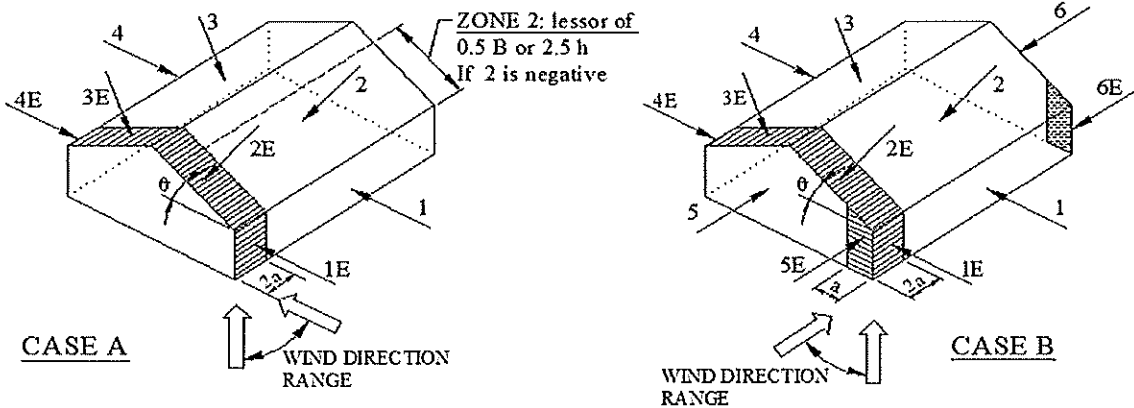


B = 400.0 ft  
# of frames (n) = 5  
Solid are of end wall including fascia (As) = 1,500.0 sf  
Roof ridge height = 46.2 ft  
Roof eave height = 42.0 ft  
Total end wall area if solid (Ae) = 17,633.3 sf

Longidinal Directional Force (F) = pAe  
p = qh [(GCpf)windward - (GCpf)leeward] K<sub>B</sub> K<sub>S</sub>  
Solidarity ratio (Φ) = 0.085  
n = 5  
K<sub>B</sub> = 0.8  
K<sub>S</sub> = 0.761  
Zones 5 & 6 area = 16,910 sf  
5E & 6E area = 723 sf  
(GCpf) windward - (GCpf) leeward] = 0.704  
p = 9.7 psf

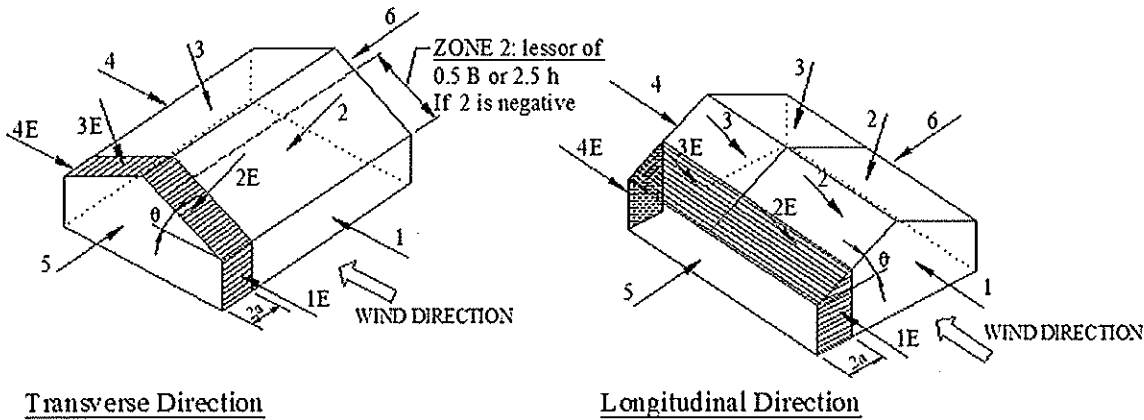
Total force to be resisted by MWFRS (F) = **170.7 kips** applied at the centroid of the end wall area Ae

Note: The longitudinal force acts in combination with roof loads calculated elsewhere for an open or partially enclosed building.



NOTE: Torsional loads are 25% of zones 1 - 6. See code for loading diagram.  
Exception: One story buildings  $h < 30'$  and 1 to 2 story buildings framed with light-frame construction or with flexible diaphragms need not be designed for the torsional load case.

**ASCE 7-98 & ASCE 7-10 (& later) - MWFRS wind pressure zones**



NOTE: Torsional loads are 25% of zones 1 - 4. See code for loading diagram.  
Exception: One story buildings  $h < 30'$  and 1 to 2 story buildings framed with light-frame construction or with flexible diaphragms need not be designed for the torsional load case.

**ASCE 7-02 and ASCE 7-05 - MWFRS wind pressure zones**

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**Steel Beam** Project File: Brewer.ec6

LIC#: KW-08015690, Build:20.24.02.28 CROCKETT ENGINEERING CONSULTANTS (c) ENERCALC INC 1983-2023

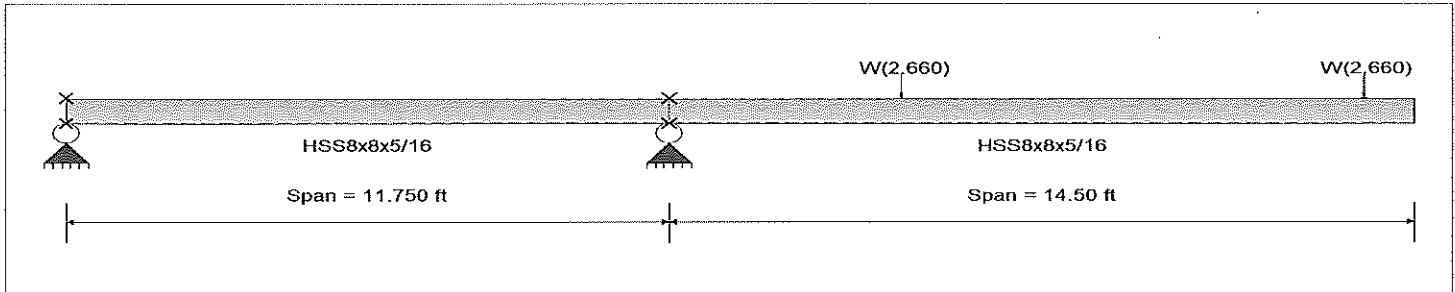
**DESCRIPTION:** cant column design full height

**CODE REFERENCES**

Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method : Allowable Strength Design	Fy : Steel Yield :	46.0 ksi
Beam Bracing : Completely Unbraced	E: Modulus :	29,000.0 ksi
Bending Axis : Major Axis Bending		



**Applied Loads**

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Load(s) for Span Number 2  
 Point Load : W = 2.660 k @ 13.50 ft

Point Load : W = 2.660 k @ 4.50 ft

**DESIGN SUMMARY**

**Design OK**

Maximum Bending Stress Ratio =	0.499 : 1	Maximum Shear Stress Ratio =	0.047 : 1
Section used for this span	HSS8x8x5/16	Section used for this span	HSS8x8x5/16
Ma : Applied	28.728 k-ft	Va : Applied	3.192 k
Mn / Omega : Allowable	57.615 k-ft	Vn/Omega : Allowable	68.552 k
Load Combination	+0.60W	Load Combination	+0.60W
Span # where maximum occurs	Span # 1	Location of maximum on span	11.750 ft
		Span # where maximum occurs	Span # 1
<b>Maximum Deflection</b>			
Max Downward Transient Deflection	2.660 in	Ratio =	130 >=120.
Max Upward Transient Deflection	-0.208 in	Ratio =	678 >=120.
Max Downward Total Deflection	1.718 in	Ratio =	203 >=120.
Max Upward Total Deflection	-0.134 in	Ratio =	1056 >=120.

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values					Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
Dsgn. L =	11.75 ft	1		0.000				96.22	57.61	1.00	1.00	-0.00	114.48	68.55
Dsgn. L =	14.50 ft	2		0.000				96.22	57.61	1.00	1.00	-0.00	114.48	68.55
<b>+0.60W</b>														
Dsgn. L =	11.75 ft	1	0.499	0.047				96.22	57.61	1.67	1.00	3.19	114.48	68.55
Dsgn. L =	14.50 ft	2	0.499	0.047	-28.73	28.73	96.22	57.61	1.00	1.00		3.19	114.48	68.55
<b>+0.450W</b>														
Dsgn. L =	11.75 ft	1	0.374	0.035				96.22	57.61	1.67	1.00	2.39	114.48	68.55
Dsgn. L =	14.50 ft	2	0.374	0.035	-21.55	21.55	96.22	57.61	1.00	1.00		2.39	114.48	68.55

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+0.70W	1	0.0000	0.000	+0.70W	-0.2077	6.815
	2	2.6729	14.500		0.0000	6.815

**Vertical Reactions**

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Max Upward from all Load Conditions		9.395	
Max Upward from Load Combinations		5.637	

Project Title:  
Engineer:  
Project ID:  
Project Descr:

## Steel Beam

Project File: Brewer.ec6

LIC# : KW-06015690, Build:20.24.02.28

CROCKETT ENGINEERING CONSULTANTS

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**DESCRIPTION:** cant column design full height

### Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Max Upward from Load Cases		9.395	
Max Downward from all Load Conditions (Resis	-4.075		
Max Downward from Load Combinations (Resi	-2.445		
Max Downward from Load Cases (Resisting U <sub>r</sub>	-4.075		
+0.60W	-2.445	5.637	
+0.450W	-1.834	4.228	
W Only	-4.075	9.395	

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

<b>Steel Beam</b>	Project File: Brewer.ec6
LIC#: KW-06015690, Build:20.24.02.28	CROCKETT ENGINEERING CONSULTANTS
(c) ENERCALC INC 1983-2023	

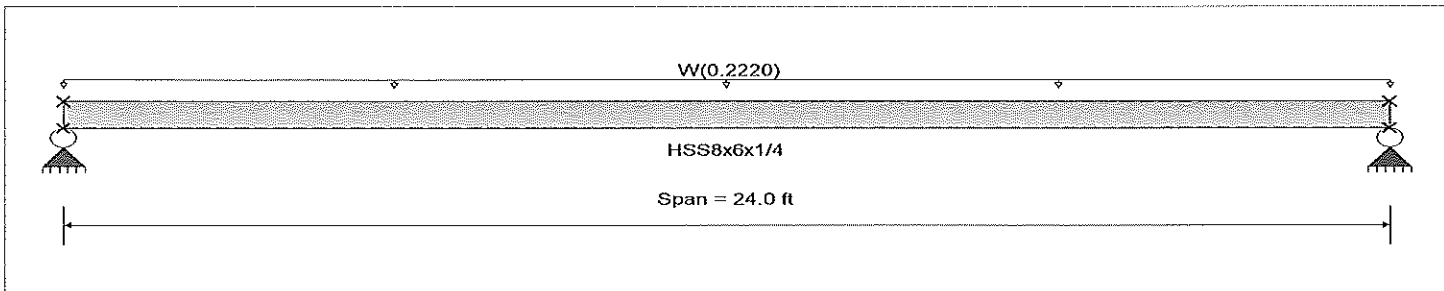
**DESCRIPTION:** screen girls spanning 24 feet

**CODE REFERENCES**

Calculations per AISC 360-16, IBC 2021, ASCE 7-16  
 Load Combination Set : ASCE 7-16

**Material Properties**

Analysis Method : Allowable Strength Design	Fy : Steel Yield : 46.0 ksi
Beam Bracing : Completely Unbraced	E: Modulus : 29,000.0 ksi
Bending Axis : Major Axis Bending	



**Applied Loads**

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added  
 Uniform Load : W = 0.2220 k/ft, Tributary Width = 1.0 ft

**DESIGN SUMMARY**

**Design OK**

Maximum Bending Stress Ratio =	0.247 : 1	Maximum Shear Stress Ratio =	0.028 : 1
Section used for this span	<b>HSS8x6x1/4</b>	Section used for this span	<b>HSS8x6x1/4</b>
Ma : Applied	9.590 k-ft	Va : Applied	1.598 k
Mn / Omega : Allowable	38.792 k-ft	Vn/Omega : Allowable	56.229 k
Load Combination	+0.60W	Load Combination	+0.60W
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	1.014 in	Ratio =	283 >=180.0
Max Upward Transient Deflection	0 in	Ratio =	0 <180.0
Max Downward Total Deflection	0.609 in	Ratio =	473 >=180.0
Max Upward Total Deflection	0 in	Ratio =	0 <180.0

**Maximum Forces & Stresses for Load Combinations**

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
Dsgn. L = 24.00 ft		1		0.000				64.78	38.79	1.00	1.00	-0.00	93.90	56.23
+0.60W														
Dsgn. L = 24.00 ft		1	0.247	0.028	9.59		9.59	64.78	38.79	1.14	1.00	1.60	93.90	56.23
+0.450W														
Dsgn. L = 24.00 ft		1	0.185	0.021	7.19		7.19	64.78	38.79	1.14	1.00	1.20	93.90	56.23

**Overall Maximum Deflections**

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
W Only	1	1.0143	12.069		0.0000	0.000

**Vertical Reactions**

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	2.664	2.664
Max Upward from Load Combinations	1.598	1.598
Max Upward from Load Cases	2.664	2.664
+0.60W	1.598	1.598
+0.450W	1.199	1.199
W Only	2.664	2.664

**Steel Base Plate**

Project File: Brewer.ec6

LIC#: KW-08015690, Build:20.24.02.28

CROCKETT ENGINEERING CONSULTANTS

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**DESCRIPTION:** screen baseplate

**Code Reference:**

Calculations per AISC Design Guide # 1, IBC 2021, ASCE 7-16, AISC 360-16

Load Combination Set : ASCE 7-16

**General Information**

**Material Properties**

AISC Design Method Allowable Strength Design

Steel Plate Fy = 50.0 ksi

Concrete Support f<sub>c</sub> = 3 ksi

Assumed Bearing Area Full Bearing

$\Omega_c$  : ASD Safety Facto

2.31

Nominal Bearing F<sub>p</sub> per J8

2.550 ksi

**Column & Plate**

**Column Properties**

Steel Section HSS8x8x5/16

Depth 8 in Area 8.76 in<sup>2</sup>

Width 8 in I<sub>xx</sub> 85.6 in<sup>4</sup>

Flange Thickness 0.291 in I<sub>yy</sub> 85.6 in<sup>4</sup>

Web Thicknes 0 in

**Plate Dimensions**

N : Length 14.0 in

B : Width 14.0 in

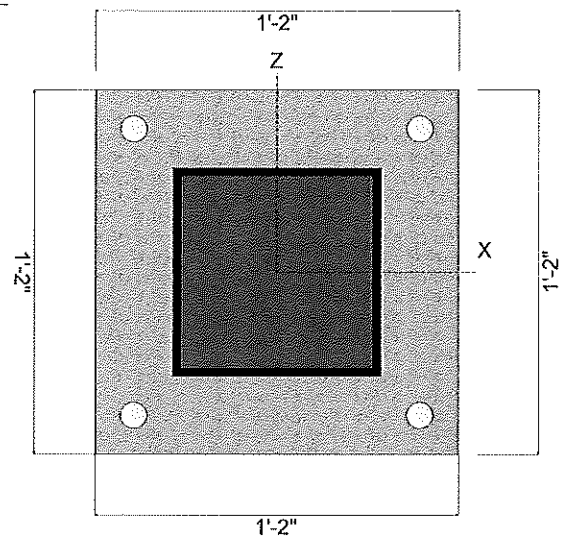
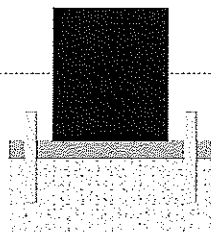
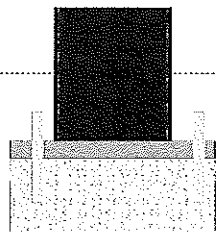
Thickness 1.250 in

**Support Dimensions**

Width along "X" 14.0 in

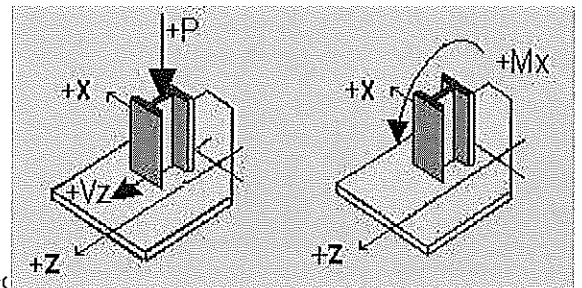
Length along "Z" 14.0 in

Column assumed welded to base plate



**Applied Loads**

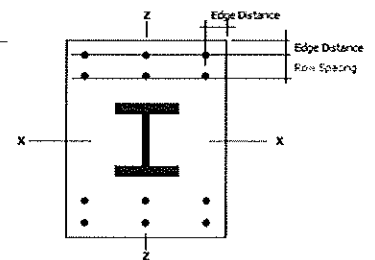
	P-Y	V-Z	M-X
D : Dead Load	6.0 k	k	k-ft
L : Live	k	k	k-ft
Lr : Roof Live	k	k	k-ft
S : Snow	k	k	k-ft
W : Wind	0.0 k	5.320 k	47.880 k-ft
E : Earthquake	k	k	k-ft
H : Lateral Earth	k	k	k-ft



" P " = Gravity load, "+" sign is downward  
 "+" Moments create higher soil pressure at +Z edge  
 "+" Shears push plate towards +Z edge

**Anchor Bolts**

Anchor Bolt or Rod Description .75	
Max of Tension or Pullout Capacity.....	29.80 k
Shear Capacity.....	15.90 k
Edge distance : bolt to plate.....	1.50 in
Number of Bolts in each Row.....	2
Number of Bolt Rows.....	1



Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**Steel Base Plate**

Project File: Brewer.ec6

LIC# : KW-06015690, Build:20.24.02.28

CROCKETT ENGINEERING CONSULTANTS

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**DESCRIPTION:** screen baseplate

**GOVERNING DESIGN LOAD CASE SUMMARY**

Plate Design Summary

Design Method            **Allowable Strength Design**  
 Governing Load Combinat **+D+0.60W**  
 Governing Load Case Typ **Axial + Moment, L/2 < Eccentricity, Tension**  
 Governing STRESS RATIO **1.0**  
 Design Plate Size        **1'-2" x 1'-2" x 1 -1/4"**  
 Pa : Axial Load ....        **3.600 k**  
 Ma : Moment .....        **28.728 k-ft**

Ma : Max. Moment .....        **7.324 k-in**  
 fb : Max. Bending Stress .....        **28.126 ksi**  
 Fb : Allowable :        **29.940 ksi**  
     Fy / Omega  
     Bending Stress Ratio        **0.939**  
     **Bending Stress OK**  
 fu : Max. Plate Bearing Stress ....        **1.104 ksi**  
 Fp : Allowable :        **1.104 ksi**  
     Bending Stress Ratio        **1.000**  
     **Bearing Stress OK**  
 Tension in each Bolt .....        **14.649**  
 Allowable Bolt Tension .....        **29.800**  
     Tension Stress Ratio        **0.492**  
     **Tension Stress OK**

Load Comb. : D Only

***Axial Load Only, No Moment***

Loading

Pa : Axial Load ....        **6.000 k**  
 Design Plate Height .....        **14.000 in**  
 Design Plate Width .....        **14.000 in**  
*Will be different from entry if partial bearing used.*  
 A1 : Plate Area .....        **196.000 in^2**  
 A2: Support Area .....        **196.000 in^2**  
     sqrt( A2/A1 )        **1.000**

Distance for Moment Calculation

" m " .....        **3.200 in**  
 " n " .....        **3.200 in**  
 X .....        **0.000 in^2**  
 Lambda .....        **0.000**  
 n' .....        **0.000 in**  
 n' \* Lambda .....        **0.000 in**  
 L = max(m, n, n") .....        **3.200 in**

Bearing Stresses

Fp : Allowable .....        **1.104 ksi**  
 fa : Max. Bearing Pressure        **0.031 ksi**  
     **Stress Ratio .....        0.028**

Plate Bending Stresses

Mmax = Fu \* L^2 / 2 .....        **0.157 k-in on 1" strip**  
 fb : Actual .....        **0.401 ksi**  
 Fb : Allowable .....        **29.940 ksi**  
     **Stress Ratio .....        0.013**

Load Comb. : +D+0.60W

***Axial Load + Moment, Ecc. > L/2***

Loading

Pa : Axial Load ....        **6.000 k**  
 Ma : Moment .....        **28.728 k-ft**  
     Eccentricity .....        **57.456 in**  
 A1 : Plate Area .....        **196.000 in^2**  
 A2 : Support Area .....        **196.000 in^2**  
     sqrt( A2/A1 )        **1.000**

Calculate plate moment from bearing . . .

max(m, n)        **3.800 in**  
 "A" : Bearing Length        **4.435 in**  
 Mpl : Plate Moment        **0.474 k-in**

Calculate plate moment from bolt tension . . .

Tension per Bolt .....        **14.136 k**  
 Tension : Allowable .....        **29.800 k**  
     **Stress Ratio .....        0.474**  
 Dist. from Bolt to Col. Edge .....        **1.700 in**  
 Effective Bolt Width for Bending .....        **6.800 in**  
 Plate Moment from Bolt Tension .....        **7.068 k-in**

Bearing Stresses

Fp : Allowable .....        **1.104 ksi**  
 fa : Max. Bearing Pressure        **( set equal to Fp )**  
     **Stress Ratio .....        1.000**

Plate Bending Stresses

Mmax .....        **7.068 k-in on 1" strip**  
 fb : Actual .....        **27.141 ksi**  
 Fb : Allowable .....        **29.940 ksi**  
     **Stress Ratio .....        0.907**

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

**Steel Base Plate**

Project File: Brewer.ec6

LIC# : KW-06015690, Build:20.24.02.28

CROCKETT ENGINEERING CONSULTANTS

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**DESCRIPTION:** screen baseplate

Load Comb. : +D+0.450W

**Axial Load + Moment, Ecc. > L/2**

Loading

Pa : Axial Load .... 6.000 k  
 Ma : Moment ..... 21.546 k-ft  
 Eccentricity ..... 43.092 in  
 A1 : Plate Area ..... 196.000 in<sup>2</sup>  
 A2 : Support Area ..... 196.000 in<sup>2</sup>  
 sqrt( A2/A1 ) ..... 1.000

Calculate plate moment from bearing . . .

max(m, n) ..... 3.800 in  
 "A" : Bearing Length ..... 3.311 in  
 Mpl : Plate Moment ..... 0.411 k-in

Calculate plate moment from bolt tension . . .

Tension per Bolt ..... 9.791 k  
 Tension : Allowable ..... 29.800 k  
 Stress Ratio ..... 0.329  
 Dist. from Bolt to Col. Edge ..... 1.700 in  
 Effective Bolt Width for Bending ..... 6.800 in  
 Plate Moment from Bolt Tension ..... 4.896 k-in

Bearing Stresses

Fp : Allowable ..... 1.104 ksi  
 fa : Max. Bearing Pressure ( set equal to Fp )  
 Stress Ratio ..... 1.000

Plate Bending Stresses

Mmax ..... 4.927 k-in on 1" strip  
 fb : Actual ..... 18.921 ksi  
 Fb : Allowable ..... 29.940 ksi  
 Stress Ratio ..... 0.632

Load Comb. : +0.60D+0.60W

**Axial Load + Moment, Ecc. > L/2**

Loading

Pa : Axial Load .... 3.600 k  
 Ma : Moment ..... 28.728 k-ft  
 Eccentricity ..... 95.760 in  
 A1 : Plate Area ..... 196.000 in<sup>2</sup>  
 A2 : Support Area ..... 196.000 in<sup>2</sup>  
 sqrt( A2/A1 ) ..... 1.000

Calculate plate moment from bearing . . .

max(m, n) ..... 3.800 in  
 "A" : Bearing Length ..... 4.257 in  
 Mpl : Plate Moment ..... 0.467 k-in

Calculate plate moment from bolt tension . . .

Tension per Bolt ..... 14.649 k  
 Tension : Allowable ..... 29.800 k  
 Stress Ratio ..... 0.492  
 Dist. from Bolt to Col. Edge ..... 1.700 in  
 Effective Bolt Width for Bending ..... 6.800 in  
 Plate Moment from Bolt Tension ..... 7.324 k-in

Bearing Stresses

Fp : Allowable ..... 1.104 ksi  
 fa : Max. Bearing Pressure ( set equal to Fp )  
 Stress Ratio ..... 1.000

Plate Bending Stresses

Mmax ..... 7.324 k-in on 1" strip  
 fb : Actual ..... 28.126 ksi  
 Fb : Allowable ..... 29.940 ksi  
 Stress Ratio ..... 0.939

Load Comb. : +0.60D

**Axial Load Only, No Moment**

Loading

Pa : Axial Load .... 3.600 k  
 Design Plate Height ..... 14.000 in  
 Design Plate Width ..... 14.000 in  
 Will be different from entry if partial bearing used.  
 A1 : Plate Area ..... 196.000 in<sup>2</sup>  
 A2 : Support Area ..... 196.000 in<sup>2</sup>  
 sqrt( A2/A1 ) ..... 1.000

Distance for Moment Calculation

" m " ..... 3.200 in  
 " n " ..... 3.200 in  
 X ..... 0.000 in<sup>2</sup>  
 Lambda ..... 0.000  
 n' ..... 0.000 in  
 n' \* Lambda ..... 0.000 in  
 L = max(m, n, n') ..... 3.200 in

Bearing Stresses

Fp : Allowable ..... 1.104 ksi  
 fa : Max. Bearing Pressure ..... 0.018 ksi  
 Stress Ratio ..... 0.017

Plate Bending Stresses

Mmax = Fu \* L<sup>2</sup> / 2 ..... 0.094 k-in on 1" strip  
 fb : Actual ..... 0.241 ksi  
 Fb : Allowable ..... 29.940 ksi  
 Stress Ratio ..... 0.008