



City of Waco, Texas

Request for Bid RFB No. 2022-091

City of Waco Convention Center HVAC Changeout – Phase 2

Issue Date: November 7, 2022

Closing Date & Time: December 5, 2022, at 2:00 p.m.

Opening Date & Time: December 5, 2022, at 2:01 p.m.

RFB Opening Location: Purchasing Services Office, 1415 N. 4th Street, Waco, Texas
(via Zoom Video Conferencing) Please see Page 2

For Information Contact: Kasey Gamblin, Purchasing Services, 254-750-8405

Pre-submittal Meeting Location: **City of Waco Convention Center
425 Franklin Ave, Waco TX 76701
On November 16, 2022 at 10:00 A.M.**

Purchasing Services
Post Office Box 2570
Waco, Texas 76702-2570
Telephone 254 / 750-8060
Fax 254 / 750-8063
www.waco-texas.com

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City of Waco, Texas

RFB No. 2022-091

City of Waco Convention Center HVAC Changeout – Phase 2

REGISTER INTEREST

You have received a copy of the above described Request document. If you would like to register your interest in this project so that you will receive any future notices or addenda concerning the project, please fill in the information requested below and fax this page to 254-750-8063. You may also scan this page and email to: kaseyg@wacotx.gov.

Company/Firm: _____

Name of Contact Person(s): _____

Email(s): _____

Telephone: _____

Fax: _____

Mailing Address: _____

It is your responsibility to complete and return this form to the City. Failure to do so will result in your not receiving notices and addenda related to this project from the City of Waco. Notices and addenda are posted on the City's website and can be accessed at:

<http://www.waco-texas.com/purchasing-rules.asp>.

City of Waco Purchasing Services

Post Office Box 2570

Waco, Texas 76702-2570

Telephone 254 / 750-8060

Fax 254 / 750-8063

www.waco-texas.com

I. Schedule for Solicitation

The proposed schedule of events is tentative and may be modified throughout the selection process at the discretion of the City of Waco.

Issuance of the RFB	November 7, 2022
Pre-Bid Conference: 10:00 A.M.	November 16, 2022
Deadline for questions is 5:00 P.M.	November 22, 2022
Bids due by 2:00 p.m.	December 5, 2022
Evaluation of submissions	December 5, 2022 thru December 9, 2022

Tentatively, the final selection decision will be made and submitters will be notified of award by December 5-9, 2022. This schedule is subject to change by the City.

II. Contact with City of Waco

The contact person for this solicitation process is: Kasey Gamblin, Purchasing Manager who can be reached at:

Email: kaseyg@wacotx.gov Telephone: (254) 750-8405 Fax: (254) 750-8063

Questions concerning the solicitation must be submitted to contact person **in writing** on or before date shown in the schedule above.

Via U.S. Mail: City of Waco Purchasing Services Attn: Kasey Gamblin, Purchasing Manager P.O. Box 2570 Waco, Texas 76702-2570	Via Delivery Services/Personal Delivery: City of Waco Purchasing Services Attn: Kasey Gamblin, Purchasing Manager 1415 North 4 th Street Waco, Texas 76707 NOTE: US Mail does NOT deliver to street address
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Contact with someone other than the Purchasing Agent listed above, or his/her designated representative, at the City of Waco concerning this solicitation may be grounds for removal from consideration.

Interpretation, modification, corrections, or changes to the solicitation documents will be made by addenda issued by the City of Waco. Addenda will be made available <https://www.waco-texas.com/bids.asp>. Interested vendors are encouraged to return the Register Interest form on the previous page.

A complete copy of this RFB, including information for bidders, bid forms, contract forms, plans, specifications, bid bond forms, performance and payment bond forms and all other contract documents related to this project are available at <https://www.waco-texas.com/bids.asp>.

III. Definitions

The following definitions apply to this document and the transaction between the City and the selected submitter unless otherwise designated in the context. Terms, which are singular, may include multiple, where applicable and when in the best interests of the City:

- (1) “City” means and refers to the City of Waco, Texas.
- (2) “Company” or “Firm” means and refers to any submitter, whether such submitter be a sole proprietor, corporation, company, partnership, company, or any other entity legally defined or recognized under the laws of the State of Texas.
- (3) “Bid” or “Submission” refers to a response submitted to an RFB.
- (4) “RFB” means and refers to a Request for Bid that will be awarded based on lowest responsible bid or best value to City of Waco.
- (5) “Selected submission” means and refers to the submission sent to the City of Waco by the Selected Firm.
- (6) “Selected Firm” means the firm who is selected by the City and to whom the City Council/City Manager awards a contract for the services or commodities requested in this solicitation.
- (7) “Solicitation” means an RFB issued by the City Waco seeking products or services described in the document.
- (8) “Submitter” or “Vendor” or “Bidder” or “Contractor” means a firm that submits a response to a solicitation.
- (9) “Contract documents” includes the RFB and all of the Appendices attached to the RFB.
- (10) “Day” means a calendar day unless otherwise specifically defined.

IV. REQUESTED SERVICES/PRODUCTS

A. Scope of Services / Specifications

- (1) The project generally consists of furnishing all labor, materials, equipment, appurtenances, and incidentals as required to remove existing HVAC equipment and replace it with the new equipment in revised location adapted to the existing structural equipment supports. Provide new controls and revised electrical as required.

The existing domestic water heater will be replaced with a new water heater under this scope. Existing domestic piping to remain and reconnect with new combustion venting installed.

- (2) Detailed specifications are attached as Appendices.

B. Terms, Conditions, and Requirements

In addition to the specifications for the Project, the attached Appendices include the City's Contract Requirements.

C. Duration of Service

It is anticipated by the City of Waco that the work of this project will be performed within **100 calendar** days from notice to proceed. It is additionally anticipated that work will not be performed on Saturdays, Sundays, or City holidays unless specifically identified on the bid and approved by City. Since "day" is defined as a calendar day, Saturdays, Sundays, and City holidays shall be counted as days and included in calculating the Contract time. If a Contractor wants to perform work on Saturdays, Sundays, or City holidays, the Contractor shall seek approval by making a written request to City. Contractor shall be responsible for all City staff and third-party time, costs, expenses and overtime for work performed on Saturdays, Sundays, or City holidays, unless excused in writing by the City prior to the work.

D. Reservations by City:

The City of Waco reserves the right to reject any and all submittals. This issuance of this solicitation does not obligate the City to contract for expressed or implied services. The City of Waco will not reimburse vendors for any costs incurred during the preparation or submittal of responses to this solicitation.

- (1) Furthermore, the City expressly reserves the right to:
 - (a) Waive any defect, irregularity, or informality in any submittal or procedure;
 - (b) Extend the solicitation closing time and date;
 - (c) Reissue this solicitation in a different form or context;
 - (d) Procure any item by other allowable means;
 - (e) Waive minor deviations from specifications, conditions, terms, or provisions of the solicitation, if it is determined that waiver of the minor

deviations improves or enhances the City's business interests under the solicitation; and/or

- (f) Extend any contract when most advantageous to the City, as set forth in this solicitation.
- (g) Retain all bids submitted and to use any ideas in a bid regardless of whether or not that bid is selected.

V. REQUEST FOR BIDS – SUBMISSION AND AWARD PROCEDURES

A. Requirements

- (1) Qualified vendors should submit one (1) original copy of the Pricing Form as well as one (1) electronic flash drive for the services/products sought by this solicitation and complete all of the required forms by the stated deadline.
- (2) Pricing Forms and Submission/Bid Security
 - (a) Pricing Forms.
 - 1. Bids are to be submitted with a response on each item and the total extended. More than one (1) bid may be submitted on items that meet the specifications and the other RFB requirements.
 - 2. Pricing is to be submitted on units of quantity specified on the Pricing Form with extended totals. In the event of a discrepancy in any extension total, the unit prices shall govern and be binding for purposes of this RFB.
 - 3. All prices included are to be submitted less Federal Excise and State of Texas Sales Taxes. A tax exemption certificate will be executed upon request. The City's federal tax identification number is 1-74-6002468-4.
 - (b) Security – Bid Bond. (**Applies only to Construction work**)
 - 1. Each submission must be accompanied by a **certified check** of the submitter, or a **bid bond** executed by the submitter as principal and having as surety thereon a surety company approved by the City in the amount of 5% of the submission. The Surety's Power of Attorney must accompany the bid bond. The bid bond and surety's Power of Attorney must both carry the same date which is no earlier than three (3) days prior to the scheduled bid opening date.
 - 2. Checks will be returned to all except the three lowest bidders within three days after the opening of bids. The remaining checks will be returned promptly after the City and the selected bidder have executed the contract.
 - 3. If no award has been made within ninety (90) days after the date of the opening of bids, a bidder may demand that the security

submitted be returned so long as said bidder has not been notified of the acceptance of his bid.

4. If the selected bidder refuses or fails to execute and deliver the contract and bonds (payment and/or performance) required within 10 days after receiving notice of the acceptance of his bid, the bid security shall forfeit to the City as liquidated damages for such failure or refusal.
5. A Bid Bond form can be found in the Appendices.

(c) Equipment Submittals

1. Each submission should be accompanied by a complete equipment submittal for the equipment bidder proposes to use for the project.
2. Refer to project specification and drawings for submittal requirements.

B. Completeness of Submission

- (1) Vendors are responsible for examining and being familiar with all specifications, drawings, standard provisions, instructions, and terms and conditions of the solicitation and their responses.
- (2) The vendor must attach all required forms with each submission copy. Forms must be signed by a representative of the vendor authorized to bind the vendor contractually. The vendor must include a statement identifying any exceptions to this RFB or declare that there are no exceptions taken to the RFB.

C. Bid Response Date and Location

Bids must be received at the office of Purchasing Department by 2:00 p.m. (Central Time) on December 5, 2022.

Interested parties may submit their bids **Via Delivery Services or Personal Delivery** to:

City of Waco Purchasing Services
Attn: Kasey Gamblin, Purchasing Manager
1415 North 4th Street
Waco, Texas 76707

Interested parties may also submit their bids through **U.S. Mail** delivered to:

City of Waco Purchasing Services
Attn: Kasey Gamblin, Purchasing Manager
P.O. Box 2570
Waco, Texas 76702-2570

If using U.S. Mail, note that U.S. Mail is initially received at Waco City Hall and then delivered to the office of Purchasing Services by a City courier. That delivery may occur a day or more after being received at Waco City Hall. Allow additional time in advance of

the bid due date for U.S. Mail delivery. If the Purchasing Office has not received the bids by the stated deadline, the bid will be returned unopened.

All submittals shall be sent to the attention of the Purchasing Agent in a sealed envelope that is clearly marked on the outside as follows:

**“RFB 2022-091, City of Waco Convention Center HVAC
Changeout – Phase 2”**

**Bid Opening: 2:01 p.m. (Central Time) on December 5, 2022, via Zoom
Video Conferencing. Please see Page 2**

Vendors accept all risk of late delivery bids regardless of instance or fault. A bid received after the submission deadline will not be considered and will be returned unopened to the submitter. Vendors accept all risks of delivery.

The City will NOT accept a response submitted by facsimile transmission (fax) or by electronic mail (email).

All submissions and accompanying documentation will become the property of the City.

D. Modification to or Withdrawal of Submission

Submissions cannot be altered or amended after the submission deadline passes. Submissions may be modified prior to the deadline by providing a written notice to the Purchasing contact person at the address previously stated. To modify a submission prior to the submission deadline:

- (1) Submit a written notice of the modification WITHOUT revealing the bid price. The modification should provide the addition, subtraction, or other modifications so that the final prices or terms will not be revealed to the City until the sealed bid is opened.
- (2) The written modification may be submitted by electronic transmission (fax or email or personal delivery to Purchasing Agent identified earlier in this document. The written modification must be received by the City prior to the closing time.
- (3) If the modification is submitted through an electronic transmission (fax or email), the City must receive an original of the modification document signed by the bidder and submitted to a delivery company (UPS, FedEx, etc.) prior to the bid closing time. If the original of the modification was not submitted to a delivery company prior to the closing time or is not received within three (3) days after the closing time of the bid, consideration will not be given to the modifications provided in the electronic transmission.

A submission may also be withdrawn by providing the notice in person by a representative of the vendor who can provide proof of his authority to act for the vendor. The representative will be required to execute a receipt reflecting the submission is being withdrawn. If a submission is withdrawn before the submission deadline stated

herein, the vendor may submit a new sealed bid provided the new bid is received prior to the closing date and time deadline stated on the cover page and in the Schedule for the Solicitation. This provision does not change the common law right of a submitter to withdraw a submission due to a material mistake in the submission.

E. Submission Validity Period

A submission responding to this RFB signifies the vendor's agreement that the submission, and the content thereof, are **valid for ninety (90)** days following the submission deadline unless otherwise agreed to in writing by all parties. The submission may become part of the contract that is negotiated between the City and the successful vendor.

F. Vendor's Cost to Develop Submission

Costs for developing and assembling submissions in response to this solicitation are entirely the responsibility and obligation of the vendor and shall not be reimbursed in any manner by the City.

G. References

The submission shall include a list of 5 references, at least 3 of which have obtained services or materials from the vendor in the last 24 months.

H. Method of Award and Evaluation of Factors [x in box shows applicable]

(1) For this solicitation, the City will award the contract to the:

☒ Lowest responsible bidder

☐ Bidder who provides goods or services at the best value for the City.

(2) Lowest Responsible Bidder:

(a) The contract will be awarded to the lowest responsible bidder based on the base bid plus any selected alternatives provided the amount does not exceed the funds then estimated by the City as available to finance the contract.

(b) If the contract is bid with alternatives, the City reserves the right to select any combination of alternatives and will then compare all bids using the selected alternatives. If the amount of the bids exceeds the funds available to finance the contract, the City may (i) reject all bids or (ii) may award the contract based on the base bid with such deductions as produces a net total which is available within the available funds.

(3) Best Value:

(a) In determining best value for the City, the City may consider:

1. the purchase price;

2. the reputation of the bidder and of the bidder's goods or services;

3. the quality of the bidder's goods or services;
 4. the extent to which the goods or services meet the municipality's needs;
 5. the bidder's past relationship with the municipality;
 6. the impact on the ability of the municipality to comply with laws and rules relating to contracting with historically underutilized businesses and non-profit organizations employing persons with disabilities;
 7. the total long-term cost to the municipality to acquire the bidder's good or services; and
- (b) Compliance with all bid requirements, delivery and needs of the City are considerations in evaluating bids. The City of Waco reserves the right to contact any offeror, at any time, to clarify, verify or request information with regard to any bid.
- (4) During the evaluation process, the City reserves the right, where it may serve the City's best interest, to request additional information or clarifications from bidders.

I. Contact Award and Execution

The final contract must be awarded and approved by the Waco City Council if the amount of the contract will exceed \$50,000.00. If the contract is for less than that amount, depending on the amount, the contract may be executed by the City Manager, an Assistant City Manager, department head or director.

APPENDIX A

Services/Products Bid Forms

- (1) Pricing Form(s)
- (2) Sample Bid Bond Form

To: Honorable Mayor and City Council
City of Waco, Texas

BID FORM A
City of Waco Convention Center
HVAC Changeout – Phase 2
425 Franklin Ave
City of Waco, Texas

City of Waco RFB # 2022-091

From: _____ (Contractor Print Name Here)

I have received plans, details, and specifications for the project listed above as prepared by Reliance Architecture. I have also received Addenda Nos. _____ and have included their provisions in my bid. I have examined the documents, existing conditions and the site and submit the following bid. In submitting the bid, I agree:

1. To hold my bid open for 90 days after Bid receiving date.
2. To enter into and execute a contract, if awarded on the basis of this bid.
3. To execute the contract, if awarded, within ten (10) calendar days after notification of award, and to commence work not later than ten (10) calendar days from date of "Notice to Proceed."
4. To accomplish the work in accord with the Contract Documents.
5. **To complete the work within 100 calendar days from the Notice to Proceed.** NTP will be established after the contract is executed. If work is not completed by such time, I agree to pay to Owner as liquidated damages the sum of five hundred dollars (\$500.00) for each calendar day after such time that the work remains incomplete, calculated in accordance with the provisions of the Contract Documents. Final completion will be reached on or before fourteen days after the Certificate of Substantial Completion is issued. If work is not completed by such time, I agree to pay to the Owner additional liquidated damages of five hundred dollars (\$500.00) per day for each calendar day after such time that Final Completion is not reached.

I will perform all work of this project for the lump sum price of:

BASE BID: _____
_____ Dollars (\$ _____)

[This section intentionally left blank]

To: Honorable Mayor and City Council
City of Waco, Texas

BID FORM A
City of Waco Convention Center
HVAC Changeout – Phase 2
425 Franklin Ave
City of Waco, Texas

City of Waco RFB # 2022-091

Executed on _____, 2021.

Company Name

[If participant is a corporation]

Signature: _____

[complete the following]

Print Name: _____

Sole Owner, or Partner, or President of Corporation
(Delete titles inapplicable to signer)

ATTEST:

Whose address is:

(Corporate Seal)

Telephone: _____

Fax: _____

Email: _____

To: Honorable Mayor and City Council
City of Waco, Texas

BID FORM B
Tennis Center HVAC Replacement
425 Franklin Ave
City of Waco, Texas

City of Waco RFB # 2022-091

From: _____ (Bidding company name here)

I will adjust the contract sum in accordance with the following Unit Prices:

ITEM	DESCRIPTION	UNIT	ADD	DEDUCT
	No unit pricing requested.			

I will add for any additional work above and beyond the scope of this contract for the cost of all jobsite labor and materials furnished plus _____ percent (____%) for overhead and profit. Overhead and profit includes office personnel and expenses.

I will add for any additional work above and beyond the scope of this contract performed by a subcontractor for the cost of subcontractor plus _____ percent (____%) for overhead and profit.

I will use the following subcontractors on this work:

Trade	Subcontractor's Name	Location	MWBE?
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

To: Honorable Mayor and City Council
City of Waco, Texas

BID FORM B
Tennis Center HVAC Replacement
425 Franklin Ave
City of Waco, Texas

City of Waco RFB # 2022-091

Executed on _____, 2021.

Company Name

[If participant is a corporation]

Signature: _____

[complete the following]

Print Name: _____

Sole Owner, or Partner, or President of Corporation
(Delete titles inapplicable to signer)

ATTEST:

Whose address is:

(Corporate Seal)

Telephone: _____

Fax: _____

Email: _____

BID BOND**THE STATE OF TEXAS** §**COUNTY OF** _____ §**KNOW ALL MEN BY THESE PRESENTS, THAT** __________, (hereinafter called the Principal), as Principal,
and _____,(hereinafter called the Surety), as Surety, are bound unto the **City of Waco**, Texas, a home
rule municipal corporation of McLennan County, Texas (hereinafter called Obligee) in
the amount _____ DOLLARS
(\$_____), which is five percent (5%) of the bid, for the payment
whereof said Principal and Surety bind themselves, and their heirs, administrators,
executors, successors and assigns, jointly and severally, firmly by these presents.WHEREAS, the Principal has submitted a Bid to enter into a certain written
Contract with Obligee for *{enter description of contract below}*_____,
which is scheduled to be opened on _____, 20____.**NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS
SUCH**, that if the said Principal shall faithfully, enter into such written Contract, then this
obligation shall be void; otherwise to remain in full force and effect.**IT IS EXPRESSLY UNDERSTOOD AND AGREED** that if said Principal
should withdraw its Bid any time after such Bid is opened and before official rejection of
such Bid or, if successful in securing the award thereof, said Principal should fail to enter
into the Contract and furnish, if required, satisfactory Performance Bond and Payment
Bond, the Obligee, in either of such events, shall be entitled and is hereby given the right
to collect the full amount of this Bid Bond as liquidated damages.The Surety, for value received, hereby stipulates and agrees that the obligation of
said Surety and its bond shall be in no way impaired or affected by any extension of the
time within which the Obligee may accept such Bid, and said Surety does hereby waive
notice of any such extension.

Bid Bond – Page 2

PROVIDED, further that if any legal action be filed upon this Bond, venue shall lie in McLennan County, Texas.

IN WITNESS WHEREOF, the said Principal and Surety do sign and seal this instrument this _____ day of _____, 20_____.

ATTEST/WITNESS:

Secretary (if corporation) / Witness

Name of Principal - Contractor

(if corporation Corporate Seal)

BY: _____
signature

Title: _____

Address: _____

ATTEST:

Surety Secretary

Name of Surety

(Surety Seal)

BY: _____
Attorney-in-Fact signature

Witness to Surety

Address: _____
For Attorney in Fact

Address: _____

NOTE: Submit an original bid bond and a certified copy of the power of attorney along with full contact information for the Surety. Both the bid bond and the power of attorney should be **dated for the same date which is no earlier than three (3) business days prior to the scheduled bid opening**. [Count back from the day of the bid opening and do not count the bid opening day. Example: bid opening on Thursday, count back Wednesday, Tuesday, and Monday.] If the opening is delayed or rescheduled, Principal and/or Surety may be asked to provide proof that the bid bond executed is still valid.
(11/03/2016)

COMPLETED FORM MUST BE RETURNED WITH BID/PROPOSAL

APPENDIX B

Contract Requirements

- (1) City of Waco General Terms and Conditions
- (2) General Conditions for Construction Work
- (3) Insurance & Indemnification Requirements
- (4) Worker's Compensation
- (5) Wage Rates
- (6) Sales Tax Information
- (7) HB89 Energy Form
- (8) HB89 Gun Form
- (9) HB89 Israel Form
- (10) House Bill 1295 Information Sheet
- (11) Protest Procedure
- (12) Sample Contract Form
- (13) Sample Payment and Performance Bond Requirements

APPENDIX B.(1)

General Waco Terms and Conditions

- (a) **Applicable Law and Venue.** This solicitation and any resulting contract will be governed and construed according to the laws of the State of Texas. The terms and conditions of the contract awarded pursuant to the solicitation are fully performable in McLennan County, Texas and venue for any dispute regarding contract shall be in McLennan County, Texas.
- (b) **Arbitration / Mediation.** The City of Waco will not agree to binding or mandatory arbitration or mediation.
- (c) **Conflict of Interest.** Vendor agrees to comply with the conflict of interest provisions of the Waco City Charter, Waco Code of Ordinances, and/or state law. Vendor agrees to maintain current, updated disclosure of information on file with the Purchasing Services Division throughout the term of the contract.
- (d) **Gratuities.** The City may, by written notice to the Vendor, cancel this contract without liability to the City, if it is determined by the City that gratuities have been offered to any officer or employee of the City with a view toward securing a contract, securing favorable treatment with respect to the awarding, amending, or the making of any determinations in respect to the performance of such a contract. In the event this contract is canceled by City as set forth in this paragraph, the City shall be entitled to recover from Vendor all additional costs incurred by City as a result of the cancellation.
- (e) **Unfunded Liability.** City's obligation is payable only and solely from funds available for the purpose of this purchase. Lack of funds shall render this contract null and void to the extent funds are not available and any delivered but unpaid for goods will be returned to Vendor by City. The City will not incur a debt or obligation to pay selected bidder any amounts the City does not have the current funds available to pay, unless the contract includes a provision for the City to appropriate funding for the debt or obligation.
- (f) **Advance Payments.** The City will not make advance payments to a selected firm or any third party pursuant to this solicitation or resulting contract.
- (g) **Gift of Public Property.** The City will not agree to any terms or conditions that cause the City to lend its credit or grant public money or anything of value to the selected firm.
- (h) **Procurement Laws.** The City will not agree to any terms or conditions that cause the City to violate any federal, Texas, or local procurement laws, including its own charter.
- (i) **Limitation of Liability.** The City of Waco will not agree to an artificial limitation of liability (e.g. liability limited to contract price or liability capped at an amount actually paid in previous 3 months, etc.) or an artificial statute of limitations (e.g. any lawsuit must be commenced within one year of the event).
- (j) **Waiver.** No claim or right arising out of a breach of the contract resulting from this solicitation can be discharged in whole or in part by a waiver or renunciation of the

claim or right unless the waiver or renunciation is supported by consideration and is in writing signed by the aggrieved party.

- (k) **Right To Assurance.** Whenever one party to this contract in good faith has reason to question the other party's intent to perform, that party may request that the other party give written assurance of his intent to perform. In the event that a request is made and no assurance is given within five (5) days, the requesting party may treat this failure as an anticipatory repudiation of the contract.
- (l) **Attorney's fees; Legal Costs.** The City will not agree to pay the selected firm's attorney's fees or other legal costs under any circumstances.
- (m) **Advertising.** Vendor shall not advertise or publish, without City's prior consent, the fact that City has entered into this contract, except to the extent necessary to comply with proper requests for information from an authorized representative of the federal, state or local government.
- (n) **Arrears In Taxes.** Article VII. Taxation, Section 8, of the City of Waco Home Rule Charter states: The City shall be entitled to counterclaim and offset against any debt, claim, demand or account owed by the City to any person, firm or corporation who is in arrears to the City of Waco for taxes, in the amount of taxes so in arrears, and no assignment or transfer of such debt, claim, demand or account after the said taxes are due, shall affect the right of the City to offset the said taxes against the same.
- (o) **Tax Certification; Offset of Other Debts Against City.** Selected bidder hereby certifies that it is not delinquent in the payment of taxes owed to the City and will pay any taxes owed to the City so that such taxes will not become delinquent. If this certification is subsequently determined to be false, such false certification shall constitute grounds for termination of the contract awarded under this SOLICITATION, at the option of City. Furthermore, Selected bidder agrees the City is entitled to counterclaim and offset against any debt, claim, demand, or account owed by the City to the selected bidder, pursuant to the awarded contract, for any debt, claim, demand, or account owed to the City, including other than the taxes mentioned above. The City may withhold from payment under the awarded contract an amount equal to the total amount of debts, claims, accounts, or demands including taxes owed to the City by the selected bidder. The City may apply the amount withheld to the debts and taxes owed to the City by the selected bidder until said debts are paid in full. No assignment or transfer of such debt, claim, demand or account after the said taxes or debts are due shall affect the right of the City to offset the taxes and the debt against the same.
- (p) **Independent Contractor.** The selected bidder will be an independent contractor under the contract. Professional services provided by the selected bidder shall be by the employees or authorized subcontractors of the selected bidder and subject to supervision by the selected bidder, and not as officers, employees or agents of the City. Selected bidder will be required and agrees to comply with all state and federal employment laws as well as all other federal, state and local laws, rules and regulations affecting the performance of all obligations taken herein.

- (q) **No Joint Enterprise/Joint Venture.** It is not the intent of this solicitation or the contract to be awarded to create a joint enterprise or joint venture.
- (r) **Subcontracting Bid.** If subcontracting with another company or individual is proposed, that fact, along with providing the same information for the subcontractor that is required to be provided by the bidder under this solicitation, must be provided and clearly identified in the bid. Following the award of the contract, no additional subcontracting will be permitted without the express prior written consent of the City.
- (s) **Assignment-Delegation.** No right or interest in the contract shall be assigned or delegation of any obligation made by Vendor without the written permission of the City. Any attempted assignment or delegation by Vendor shall be wholly void and totally ineffective for all purposes unless made in conformity with this paragraph.
- (t) **Modifications:** This contract can be modified or rescinded only by a written instrument signed by both of the parties or their duly authorized agents.
- (u) **Interpretation-Parol Evidence:** This writing is intended by the parties as a final expression of their agreement and is intended also as a complete agreement for dealings between the parties and no usage of the trade shall be relevant to supplement or explain any term used in this agreement. Acceptance or acquiescence in a course of performance rendered under this agreement shall not be relevant to determine the meaning of this agreement even though the accepting or acquiescing party has knowledge of the performance and opportunity for objection.
- (v) **Equal Employment Opportunity:** Vendor agrees that during the performance of its contract it will:
 1. Treat all applicants and employees without discrimination as to race, color, religion, sex, national origin, marital status, age, or handicap.
 2. Identify itself as an "Equal Opportunity Employer" in all help wanted advertising or request. The Vendor shall be advised of any complaints filed with the City alleging that Vendor is not an Equal Opportunity Employer. The City reserves the right to consider its reports from its human relations administrator in response to such complaints in determining whether or not to terminate any portion of this contract for which purchase orders or authorities to deliver have not been included, however, the Vendor is specifically advised that no Equal Opportunity Employment complaint will be the basis for cancellation of this contract for which a purchase order has been issued or authority to deliver granted.
- (w) **Israel:** Vendor acknowledges that effective September 1, 2017, the City is required to comply with Section 2270.001 of the Texas Government Code, enacted by House Bill 89 (85th (R) Texas Legislature), which requires that a governmental entity may not enter into a contract with a company for goods or services unless the contract contains a written verification from the company that it does not boycott Israel and will not boycott Israel during the term of the contract. By executing this Agreement, Vendor verifies that it does not boycott Israel and will not boycott Israel during the term of this Agreement.

APPENDIX B.(2)

General Conditions for Construction Work

The “City of Waco Standard Specifications for Construction” (2013 Edition), hereinafter referred to as City Standard Specifications, is incorporated herein by reference for all intents and purposes. The General Provisions of the City Standard Specifications include provisions related to the administration of the contract. If a provision of the City Standard Specifications conflicts with a provision in this solicitation, the provision in this solicitation controls. If the applicable provision is still unclear, the City Manager for the City of Waco, or his designee, will determine which provisions, specification or standard controls and his determination shall be final.

The City Standard Specifications may be obtained by accessing the City of Waco website at www.waco-texas.com and going to Bid Opportunities – Engineering Services. It may also be obtained by contacting the City of Waco Public Works Department at 254-750-5440.

- (a) **Permits and Fees:** All permitting fees from the City will be waived on construction projects. The contractor will still need to apply for all applicable permits. However, there will be no cost associated with issuance of City permits.
- (b) **Time of Completion and Liquidated Damages:** Completing the work described in this solicitation in a timely manner is very important to the City of Waco. Submitter must agree to commence work on or before a date to be specified in a written "Notice to Proceed" of the City and to fully complete the project within the time stated in the contract documents. As it is impracticable and extremely difficult to fix the actual damages, if any, that may proximately result from a failure by Submitter to perform the service, should Submitter fail to complete the project within the calendar days specified in the contract, Submitter agrees to pay to City, or have withheld from monies due it, the amount stated in the contract documents as liquidated damages for each calendar day of delay or nonperformance. Any sums due and payable hereunder by the Submitter shall be payable, not as a penalty, but as liquidated damages representing an estimate of delay damages likely to be sustained by the City, estimated at the time of executing this Contract. Execution of a contract for this Project shall constitute agreement by the City and Submitter that said amount is the minimum value of the costs and actual damage caused by the failure of the Submitter to complete the Project within the allotted time. A sum due as liquidated damages may be deducted from payments due the Contractor if such delay occurs. Adjustments to the contract times can only be made as provided in the contract documents and any conditions or specifications referenced therein.

- (c) **Conditions of Work:** While the City is issuing a solicitation including specifications, each Submitter is still responsible for examining all of the issued documents, attending any pre-bid conference, making a site visit, and taking whatever steps are necessary to inform itself of the conditions relating to the project and the employment of labor thereon. Each Submitter must inform itself of the conditions relating to the project and the employment of labor thereon. Failure to do so will not relieve the Submitter awarded this contract of its obligation to furnish all material and labor necessary to carry out the provisions of the contract. Insofar as possible, the Selected Firm, in carrying out the Project, must employ such methods or means as will not cause any interruption of or interference with the work of any other contractor.
- (d) **Employment Conditions/Requirements:** Submitters shall pay particular attention to the required employment conditions that must be observed and the minimum wage rates to be paid. If federal or state funds are involved in paying for the work, there may be additional requirements that must be followed to comply with the terms of the federal or state funding.
- (e) **Security for Faithful Performance [Payment and Performance Bonds]:** Simultaneously with his delivery of the executed contract, the Selected Firm shall furnish the required surety bonds as security for faithful performance of this contract (Performance Bond) and for the payment of all persons performing labor on the project under this contract and furnishing materials in connection with this contract (Payment Bond), as specified in the documents included herein. For public works contracts, state law requires a Performance Bond if the contract is for an amount in excess of \$100,000.00 and a Payment Bond if the contract is for an amount in excess of \$50,000.00. The surety on such bond or bonds shall be a duly authorized surety company satisfactory to the City. The surety who signs contract bonds must file with each bond a certified and effectively dated copy of their power of attorney.
- (f) **Force Majeure:** In the event performance by the Selected Firm of its obligations under this Agreement shall be interrupted or delayed by or as a consequence of a fire, flood, severe weather, or other act of God, war, insurrection, civil disturbance, or act of state, the Selected Firm shall be excused from such performance for the period of time such occurrence shall have lasted or such period as is reasonably necessary to rebuild or take other action necessary to resume performance. The period of time reasonably necessary to rebuild or take other action necessary to resume performance shall be as determined by the agreement of the parties, which agreement shall be negotiated and arrived at in good faith. The Selected Firm shall notify the Contact Person or Contract Administrator of any matter covered above, the occurrence of which interferes or threatens to interfere with the performance of any of its obligations under the bid. Upon such notice, the Selected Firm and the City shall consult and cooperate as to measures which may be taken to overcome the interference or as to alternative measures which may be undertaken by the parties with a view to the continued performance of the bid agreement.

- (g) **Right to Assurance:** Whenever one party to this contract in good faith has reason to question the other party's intent to perform, the questioning party may demand the other party give written assurance of its intent to perform. In the event that a demand is made, and no assurance is given within five (5) days, the demanding party may treat this failure as an anticipatory repudiation of the contract.
- (h) **Invoice Submittal Procedures:** If invoices are submitted or otherwise used pursuant to the bid awarded under this solicitation, the Selected Firm shall present invoices to the City in the following form and content:
1. Each invoice must reference the City of Waco contract, agreement or Purchase Order number;
 2. Only one contract, agreement, or project shall be billed on a particular invoice;
 3. Only one invoice per every thirty (30) days per contract, agreement, or project may be submitted; and
 4. Each invoice must have a billing number, which reflects in sequence the number of invoices that have been submitted on the contract, agreement, or project.

The invoice requirements stated herein shall not be read to disallow or exclude other information that may be otherwise required or requested by the City. Such information required herein must be submitted only on an invoice and not in any other non-invoice form or document.

- (i) **Termination of Contract:** Except as provided elsewhere in the contract documents:
1. The City may terminate the contract for cause for Selected Firm's failure to perform work, non-adherence to established federal, state and/or local laws, or a violation of any of the contract provisions. Upon written termination, the City may exclude the Selected Firm from the Project site and pursue any remedies available to the City.
 2. Upon ten (10) days written notice, City may terminate the contract for convenience, for any reason. In such case, the Selected Firm shall be paid, without duplication, for completed and acceptable work and expenses, including reasonable overhead and profit, and for other reasonable expenses directly attributable to the termination. In no case shall the Selected Firm be paid for anticipated profits or other consequential damages. Upon receipt of written notice, the Selected Firm shall have a duty to mitigate its termination costs and shall not incur additional costs unrelated to the costs directly related to either securing completed work or winding down the Project.

City of Waco Insurance & Indemnification Requirements
Vertical Construction with Builder's Risk (03/22/2019)

Insurance Requirements:

A contractor's financial integrity is of interest to the City. Therefore, subject to a contractor's right to maintain reasonable deductibles, a contractor shall obtain and maintain in full force and effect for the duration of the contract, and any extension hereof, at contractor's sole expense, insurance coverage written on an occurrence basis by companies authorized to do business in the State of Texas that are rated A- or better by A.M. Best Company and/or otherwise acceptable to the City in the following types and amounts:

Type	Amount
Workers' Compensation	Statutory
Employer's Liability	\$1,000,000/\$1,000,000/\$1,000,000
Commercial General Liability Including: <ul style="list-style-type: none"> • Premises/Operations • Independent Contractors • Products Liability/Completed Operations • Personal & Advertising Injury • Broad form property damage, to include fire legal liability 	\$1,000,000 per occurrence; \$2,000,000 General Aggregate, or its equivalent in Umbrella or Excess Liability Coverage
Business Automobile Liability <ul style="list-style-type: none"> a. Owned/leased vehicles b. Non-owned vehicles c. Hired vehicles 	\$1,000,000 per occurrence or its equivalent on a combined single limit (CSL basis).
All Risk Builder's Risk <ul style="list-style-type: none"> • Including Flood and Earthquake • City as named insured or additional insured • Replacement Cost 	Amount of the contract or replacement value of the facility.

Term of Policy: With regard to any approved claims-made policy form, a contractor shall maintain and keep in force and effect said coverage during the term of this contract and for a period of seven (7) years following the expiration or completion of the contract with the City, either through an existing carrier or a carrier of comparable financial statute and reputation.

Unless otherwise agreed to in the contract documents, Builders Risk coverage can be terminated at the time that the City accepts the structure as substantially complete, unless the project is being completed in phases; then the coverage shall remain in effect until the City accepts the entire structure or structures as substantially complete.

Modification of Insurance Requirement: The City reserves the right to review these insurance requirements during the effective period of the contract and any extension or renewal hereof and to modify insurance coverages and their limits when deemed necessary and prudent by City's Risk

Manager or designee, based upon changes in statutory law, court decisions, or circumstances surrounding this contract.

Proof of Insurance Required and When to Submit:

Examination & Approval. All insurance policies shall be subject to the examination and approval of the City for their adequacy as to form and content, form of protection, and financial status of insurance company.

When to Submit. Prior to the execution of the contract by the City of Waco and before commencement of any work under this contract, a contractor shall furnish original proof of insurance to the City's Risk Manager which is clearly labeled with the contract name and City department. The proof will include completed/current Certificate(s) of Insurance, endorsements, exclusions, and/or relevant extracts from the insurance policy, or copies of policies. Thereafter, new certificates, policy endorsements, exclusions, and/or relevant extracts from insurance policies, or policies shall be provided prior to the expiration date of any prior certificate, endorsement, or policy. No officer or employee other than the City's Risk Manager or designee shall have authority to waive this requirement.

Additional Insured. Except for Workers' Compensation and Employers' Liability, the City, its elected officials, officers, servants, agents, volunteers and employees shall be named as additional insureds. No officer or employee, other than the City Risk Manager or designee, shall have authority to waive this requirement.

Other-Insurance Endorsement -- All insurance policies are to contain or be endorsed to state that an "Other Insurance" clause shall not apply to the City where the City is an additional insured shown on the policy.

Agent Information. The certificate(s) or other proof of insurance must be completed by the broker of record and must be signed and include the agent information including the agent name, title and phone number. The proof of insurance shall be sent directly from the insurance agent to the City's Risk Management Office by U.S. Postal Service to City of Waco, ATTN: Risk Manager, P.O. Box 2570, Waco, Texas 76702-2570 or by delivery service to 1415 North 4th Street, Waco, Texas 76707. To send by email, please contact the Risk Management Office at 254-750-5730 to obtain the email address.

Precondition to Performance & Basis for Termination. The City shall have no duty to pay or perform under the contract until such certificate(s), policy endorsements, exclusions, and/or relevant extracts from the insurance policy have been delivered to and approved by the City's Risk Manager. The contractor understands that it is the contractor's sole responsibility to provide this necessary information to the City and that failure to timely comply with these insurance requirements shall be a cause for termination of a contract. If the City determines that it will deny payment, not perform, or terminate the contract because of the failure to provide certain information or documents, the City shall give the contractor notice of that determination and allow contractor fifteen (15) days to correct the deficiency.

Waiver of Subrogation. All liability policies will provide a waiver of subrogation in favor of the City.

Notice of Cancellation, Non-renewal, Material Change. The Contractor shall provide written notification to the City of the cancellation, non-renewal, or material change of any insurance required herein. The Contractor shall provide such written notice within five (5) business days of the date the Contractor is first aware of the cancellation, non-renewal, or material change, or is first aware that

the cancellation, non-renewal, or material change is threatened or otherwise may occur, whichever comes first. Contractor shall provide the City with a replacement certificate(s) of insurance, policy endorsements, exclusions, and/or relevant extracts from the insurance policy either before the cancellation, non-renewal, or material change is effective, if it knew in advance of such, or within ten (10) business days of first learning of the cancellation, non-renewal, or change if it did not learn of that such action in advance.

INDEMNIFICATION.

A CONTRACTOR EXECUTING A CONTRACT WITH THE CITY AGREES TO ASSUME FULL RESPONSIBILITY AND LIABILITY FOR THE SERVICES RENDERED PURSUANT TO THE CONTRACT AND AGREES TO INDEMNIFY, PROTECT, DEFEND, AND HOLD HARMLESS THE CITY, ITS EMPLOYEES, AGENTS, AND SERVANTS, OF AND FROM ALL CLAIMS, DEMANDS, AND CAUSES OF ACTIONS OF EVERY KIND AND CHARACTER, INCLUDING THE COST OF DEFENSE THEREOF, FOR ANY INJURY TO, INCLUDING DEATH OF, PERSONS AND ANY LOSSES FOR DAMAGES TO PROPERTY CAUSED BY OR ALLEGED TO BE CAUSED, ARISING OUT OF, OR ALLEGED TO ARISE OUT OF, EITHER DIRECTLY OR INDIRECTLY, OR IN CONNECTION WITH, THE SERVICES TO BE RENDERED HEREUNDER, WHETHER OR NOT SAID CLAIMS, DEMANDS, CAUSES OF ACTIONS ARE CAUSED BY CONCURRENT NEGLIGENCE OF THE CITY AND A PARTY TO THIS AGREEMENT, OR WHETHER IT WAS CAUSED BY CONCURRENT NEGLIGENCE OF THE CITY AND SOME OTHER THIRD PARTY.

Employee Litigation: In any and all claims against any party indemnified hereunder by any employee (or the survivor or personal representative of such employee) of the contractor, any subcontractor, any supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the work, or anyone for whose acts any of them may be liable, the indemnification obligation herein shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for contractor or any such subcontractor, supplier, or other individual or entity under workers' compensation or other employee benefit acts.



City of Waco Workers' Compensation Coverage Verification Form

The City of Waco, a State of Texas Governmental Entity and Municipality, is required to comply with the Texas Labor Code. Specifically, **Texas Labor Code – Section 406.096** directs Contractors who enter into a building or construction Contract with a Municipality to certify in writing that (1) they provide workers' compensation insurance coverage for each employee of the contractor employed on public projects, and (2) they receive a certificate from each subcontractor showing that every employee of the subcontractor is covered by workers' compensation insurance.

For your convenience, Texas Labor Code – Section 406.096 is attached.

Please review Section 406.096 prior to completing the City of Waco Workers' Compensation Coverage Verification Form.

If you have questions concerning this form, contact City of Waco Risk Management office at (254) 750-5730.

LABOR CODE

TITLE 5. WORKERS' COMPENSATION

SUBTITLE A. TEXAS WORKERS' COMPENSATION ACT

CHAPTER 406. WORKERS' COMPENSATION INSURANCE COVERAGE

EXTRACT:

Sec. 406.096. REQUIRED COVERAGE FOR CERTAIN BUILDING OR CONSTRUCTION CONTRACTORS. (a) A governmental entity that enters into a building or construction contract shall require the contractor to certify in writing that the contractor provides workers' compensation insurance coverage for each employee of the contractor employed on the public project.

(b) Each subcontractor on the public project shall provide such a certificate relating to coverage of the subcontractor's employees to the general contractor, who shall provide the subcontractor's certificate to the governmental entity.

(c) A contractor who has a contract that requires workers' compensation insurance coverage may provide the coverage through a group plan or other method satisfactory to the governing body of the governmental entity.

(d) The employment of a maintenance employee by an employer who is not engaging in building or construction as the employer's primary business does not constitute engaging in building or construction.

(e) In this section:

(1) "Building or construction" includes:

(A) erecting or preparing to erect a structure, including a building, bridge, roadway, public utility facility, or related appurtenance;

(B) remodeling, extending, repairing, or demolishing a structure; or

(C) otherwise improving real property or an appurtenance to real property through similar activities.

(2) "Governmental entity" means this state or a political subdivision of this state. The term includes a municipality.

Acts 1993, 73rd Leg., ch. 269, Sec. 1, eff. Sept. 1, 1993.

**Office Use Only**

Date Received:

City of Waco Workers' Compensation Coverage Verification Form. For Building or Construction Contractors

This form is being filed in accordance with Texas Labor Code – Section 406.96. Required Coverage For Certain Building Or Construction Contractors.

1. Name of Company doing business with the City of Waco.

_____.

2. Company Primary Point of Contact for Insurance issues.

Name: _____ Phone: _____.

Address: _____.

Email: _____
(Optional)

3. Name of Insurance Company providing Workers' Compensation Coverage for Company Employees.

Name	Address	Phone
_____	_____	_____
_____	_____	_____
_____	_____	_____

4. Is this an update to previously provided information on workers' compensation insurance?

_____ YES _____ NO.

Note: Please inform the City of Waco of changes in Insurance Companies.

5. Has the Company hired one or more Subcontractors for this project?

_____ YES _____ NO

6. Has each Subcontractor provided the Company with a certificate showing workers' compensation insurance coverage for each of the Subcontractor's employees?

_____ YES _____ NO

7. Name of each Subcontractor and Name of its Insurance Carrier providing Workers' Compensation Coverage for Subcontractor's Employees:

Subcontractor

Insurance Carrier

Please provide a copy of each Subcontractor's proof of Workers' Compensation Coverage.

8. **Printed Name and Title of person completing this form, and have Witness sign.**

Print Name: _____ Title: _____

Signature: _____ Date Signed: _____

WITNESS:

Signature: _____ Date Signed: _____

Print Name: _____

Print Title: _____

PLEASE SIGN AND RETURN WITH BID



PREVALING WAGE RATES INFORMATION

Texas Government Code Chapter 2258 requires a worker employed by a contractor or subcontractor in the execution of a contract for the public work by or on behalf of political subdivision of the state to be paid a prevailing wage rate.

Definition of “public work.” A public work to which this provision applies includes but is not limited to construction of a building, highway, road, excavation, and repair work or other project development or improvement, paid for in whole or in part from public funds, without regard to whether the work is done under public supervision or direction. It does not apply to work done directly by a public utility company under an order of a public authority. Whether this Project is a public work shall be determined by the City, and such determination shall be provided in writing to the Contractor before the opening of bids.

Worker wage rate. Contractor agrees, covenants, and guarantees that it and its subcontractor(s) constructing this Project, if a public work, shall pay their workers, other than maintenance workers, employed on this Project:

1. not less than the general prevailing rate of per diem wages for work of a similar character performed within the geographical limits of the City; and
2. not less than the general prevailing rate of per diem wages for legal holiday and overtime work.

"Worker employed on a public work" defined. A worker is employed on a public work for the purposes of this provision if the worker, including a laborer or mechanic, is employed by a contractor or subcontractor in the execution of a contract for a public work with the City, or any officer of the City, or the City Council of the City of Waco.

Determination of prevailing wage rate. The City Council of the City of Waco shall determine the general prevailing rate of per diem wages to be paid for each craft or type of worker needed to construct the Project by:

1. conducting a survey of the wages received by classes of workers employed on public works of a character similar to the contract work in the geographical limits of the City in which this public work is to be performed; or
2. using the prevailing wage rate as determined by the United States Department of Labor in accordance with the Davis-Bacon Act (40 U.S.C. Section 276a et seq.) if the survey used to determine that rate was conducted within a three-year period preceding the date the City Council of the City of Waco issues invitations for bids for this public work.

Sum certain of prevailing wage rate. The City Council shall determine the general prevailing rate of per diem wages as a sum certain, expressed in dollars and cents.

Wage rates incorporated in agreement and in invitation to bid. The prevailing wage rate to be paid for each craft or type of worker needed to construct the public work shall be specified in the invitation to bid for this Project and is incorporated by reference herein.

Determination final. The City Council's determination of the general prevailing rate of per diem wages is final.

Penalty. A contractor or subcontractor who violates this provision shall pay to the City sixty dollars (\$60) for each worker employed for each calendar day or part of the day that the worker is paid less than the wage rates stipulated in the invitation to bid and this contract. The City Council shall use any money collected under this provision to offset the costs incurred in the administration of this provision. A contractor or subcontractor does not violate this provision if the City Council, in awarding the bid for this contract, does not determine the prevailing wage rates and specify the rates in the invitation to bid and in this contract.

Maintenance of wage record. Contractor agrees, covenants, and guarantees that it and its subcontractor(s) shall keep a record showing:

1. the name and occupation of each worker employed by the contractor(s) and subcontractor(s) in the construction of this public work; and
2. the actual per diem wages paid to each worker.

Inspection of wage record. The record shall be open at all reasonable hours to inspection by the officers and agents of the City.

Payment greater than prevailing rate not prohibited. This provision does not prohibit the payment to a worker employed on a public work an amount greater than the general prevailing rate of per diem wages.

Reliance on certificate of subcontractor. The contractor awarded this bid is entitled to rely on a certificate by a subcontractor regarding the payment of all sums due those working for the subcontractor until the contrary has been determined.

Duty of City to hear complaints and withhold payment. The City Council shall:

1. take cognizance of complaints of all violations of this provision committed in the execution of the construction of this public work; and
2. withhold money forfeited or required to be withheld under this provision from the payments to the contractor(s) under the bid contract, except that the City may not withhold money from other than the final payment without a determination by the City Council that there is good cause to believe that the contractor has violated this provision.

Complaint; initial determination. The City Council shall comply with Sections 2258.023 and 2258.056, Government Code, in the initial determination of a complaint presented pursuant to this provision.

For the purposes of this Project, the general prevailing rate of per diem wages are the wage the rates set forth on the following page(s).

"General Decision Number: TX20220260 10/14/2022

Superseded General Decision Number: TX20210260

State: Texas

Construction Type: Building

County: McLennan County in Texas.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	<ul style="list-style-type: none"> . Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least \$15.00 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2022.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	<ul style="list-style-type: none"> . Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least \$11.25 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2022.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at <https://www.dol.gov/agencies/whd/government-contracts>.

Modification Number	Publication Date
0	01/07/2022
1	02/25/2022

11/3/22, 10:49 AM

SAM.gov

2 06/17/2022
 3 08/05/2022
 4 10/14/2022

BOIL0074-003 01/01/2021

	Rates	Fringes
BOILERMAKER.....	\$ 29.47	24.10

ELEC0072-002 06/01/2022

	Rates	Fringes
ELECTRICIAN.....	\$ 29.05	3%+8.83

ENGI0178-005 06/01/2020

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
(1) Tower Crane.....	\$ 32.85	13.10
(2) Cranes with Pile Driving or Caisson Attachment and Hydraulic Crane 60 tons and above.....	\$ 28.75	10.60
(3) Hydraulic cranes 59 Tons and under.....	\$ 32.35	13.10

IRON0084-011 06/01/2022

	Rates	Fringes
IRONWORKER, ORNAMENTAL.....	\$ 26.76	7.88

PLUM0286-011 06/06/2022

	Rates	Fringes
PIPEFITTER (Excludes HVAC Pipe Installation).....	\$ 33.15	15.37

* PLUM0529-002 10/01/2022

	Rates	Fringes
Plumber.....	\$ 31.00	11.84

* SUTX2014-036 07/21/2014

	Rates	Fringes
BRICKLAYER.....	\$ 18.00	0.00
CARPENTER, Excludes Drywall Hanging, and Metal Stud Installation.....	\$ 14.76 **	0.00
CEMENT MASON/CONCRETE FINISHER...	\$ 13.13 **	0.00
DRYWALL HANGER AND METAL STUD INSTALLER.....	\$ 14.27 **	0.00
GLAZIER.....	\$ 20.00	0.00

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HVAC MECHANIC (Installation of HVAC Unit Only).....	\$ 15.00	1.56
INSULATOR - MECHANICAL (Duct, Pipe & Mechanical System Insulation).....	\$ 19.77	7.13
IRONWORKER, REINFORCING.....	\$ 13.35 **	0.00
IRONWORKER, STRUCTURAL.....	\$ 20.50	5.15
LABORER: Common or General.....	\$ 11.10 **	0.00
LABORER: Mason Tender - Brick...	\$ 8.00 **	0.00
LABORER: Mason Tender - Cement/Concrete.....	\$ 9.93 **	0.00
LABORER: Pipelayer.....	\$ 12.49 **	2.13
LABORER: Roof Tearoff.....	\$ 11.28 **	0.00
OPERATOR: Backhoe/Excavator/Trackhoe.....	\$ 13.59 **	1.60
OPERATOR: Bobcat/Skid Steer/Skid Loader.....	\$ 13.93 **	0.00
OPERATOR: Bulldozer.....	\$ 18.29	1.31
OPERATOR: Drill.....	\$ 16.22	0.34
OPERATOR: Forklift.....	\$ 15.00	0.00
OPERATOR: Grader/Blade.....	\$ 14.34 **	1.68
OPERATOR: Loader.....	\$ 14.01 **	0.44
OPERATOR: Mechanic.....	\$ 17.52	3.33
OPERATOR: Paver (Asphalt, Aggregate, and Concrete).....	\$ 16.03	0.00
OPERATOR: Roller.....	\$ 13.11 **	0.00
PAINTER (Brush, Roller, and Spray).....	\$ 13.00 **	0.00
ROOFER.....	\$ 13.75 **	0.00
SHEET METAL WORKER (HVAC Duct Installation Only).....	\$ 19.00	5.73
SHEET METAL WORKER, Excludes HVAC Duct Installation.....	\$ 14.62 **	0.00
TILE FINISHER.....	\$ 11.22 **	0.00
TILE SETTER.....	\$ 14.74 **	0.00
TRUCK DRIVER: Dump Truck.....	\$ 12.24 **	1.62
TRUCK DRIVER: Flatbed Truck.....	\$ 19.65	8.57
TRUCK DRIVER: Semi-Trailer		

11/3/22, 10:49 AM

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Truck.....\$ 12.50 ** 0.00

TRUCK DRIVER: Water Truck.....\$ 12.00 ** 4.11

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 (\$15.00) or 13658 (\$11.25). Please see the Note at the top of the wage determination for more information.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at <https://www.dol.gov/agencies/whd/government-contracts>.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the

11/3/22, 10:49 AM

SAM.gov

most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISIO"

TEXAS SALES TAX EXEMPTION INFORMATION

Under section 151.309 of the Texas Tax Code, the City of Waco is exempt the payment of sales tax. In addition, when the City contracts with a third party to make certain improvements to real property, purchases of materials/consumable items that are physically incorporated into that real property are also exempt from sales tax. In other words, materials and supplies that are entirely consumed or used up on a construction job for the City of Waco can be purchased without paying state and local sales tax. Items qualifying for this exemption must be used up entirely on a job for the City of Waco.

To claim this exemption, a contractor purchasing materials and supplies (as the buyer of the materials and supplies) will have to complete a Texas Sales and Use Tax Exemption Certification form to submit to the seller at the time of the purchase. The exemption form is available on the Texas Comptroller website at:

<http://www.window.state.tx.us/taxinfo/taxforms/01-forms.html>
<http://www.window.state.tx.us/taxinfo/taxforms/01-339.pdf>

(The City of Waco will provide an executed exemption certification to the contractor awarded a construction contract to assist in making claim for the sales tax exemption for materials to be used under that contract.)

In completing the exemption form, a contractor will:

- (1) list itself as the purchaser, not the City of Waco;
- (2) fill in the name and required information about the seller;
- (3) describe the item being purchased or attached order or invoice – the only items included must be items that will be entirely consumed or used in the project for the City of Waco;
- (4) state reason for claiming the exemption (suggested wording – “Taxable item purchased for use under contract to improve realty for exempt organization, namely the City of Waco, Texas, for Project or Job No. ____” or “Materials/supplies will be used entirely in an exempt contract for the City of Waco, Texas, for Project or Job No. ____”).

The state statutes and rules related to sales tax can be accessed from the Texas Comptroller website:

<http://www.window.state.tx.us/taxinfo/sales/>

State statutes regarding sales tax can be found in Texas Tax Code Chapter 151 at:

<http://www.capitol.state.tx.us/statutes/docs/TX/content/htm/tx.002.00.000151.00.htm>

Rules related to sales tax in the Texas Administrative Code can be found at:

[http://info.sos.state.tx.us/pls/pub/readtac\\$ext.ViewTAC?tac_view=5&ti=34&pt=1&ch=3&sch=O&rl=Y](http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=5&ti=34&pt=1&ch=3&sch=O&rl=Y)
 34 TAC Section 3.291 in Subchapter O deals specifically with Contractors.

The above information is being provided to assist contractors and is therefore general in nature. It is not a substitute for advice from the contractor’s attorney or accountant.

PLEASE SIGN AND RETURN WITH BID



Texas Sales and Use Tax Resale Certificate

Name of purchaser, firm or agency as shown on permit	Phone (<i>Area code and number</i>)
Address (<i>Street & number, P.O. Box or Route number</i>)	
City, State, ZIP code	
Texas Sales and Use Tax Permit Number (<i>must contain 11 digits</i>) <div style="border: 1px solid black; height: 20px; width: 100%; position: relative;"><div style="position: absolute; left: 5px; top: 5px;"> </div><div style="position: absolute; right: 5px; top: 5px;"> </div><div style="position: absolute; left: 60px; top: 5px;"> </div><div style="position: absolute; left: 85px; top: 5px;"> </div><div style="position: absolute; left: 110px; top: 5px;"> </div><div style="position: absolute; left: 135px; top: 5px;"> </div><div style="position: absolute; left: 160px; top: 5px;"> </div><div style="position: absolute; left: 185px; top: 5px;"> </div><div style="position: absolute; left: 210px; top: 5px;"> </div><div style="position: absolute; left: 235px; top: 5px;"> </div><div style="position: absolute; left: 260px; top: 5px;"> </div><div style="position: absolute; left: 285px; top: 5px;"> </div></div>	
Out-of-state retailer's registration number or Federal Taxpayers Registry (RFC) number for retailers based in Mexico <div style="border: 1px solid black; height: 20px; width: 100%; position: relative;"><div style="position: absolute; left: 5px; top: 5px;"> </div><div style="position: absolute; right: 5px; top: 5px;"> </div></div> (<i>Retailers based in Mexico must also provide a copy of their Mexico registration form to the seller.</i>)	

I, the purchaser named above, claim the right to make a non-taxable purchase (for resale of the taxable items described below or on the attached order or invoice) from:

Seller: _____

Street address: _____

City, State, ZIP code: _____


Description of items to be purchased on the attached order or invoice:

Description of the type of business activity generally engaged in or type of items normally sold by the purchaser:

The taxable items described above, or on the attached order or invoice, will be resold, rented or leased by me within the geographical limits of the United States of America, its territories and possessions or within the geographical limits of the United Mexican States, in their present form or attached to other taxable items to be sold.

I understand that if I make any use of the items other than retention, demonstration or display while holding them for sale, lease or rental, I must pay sales tax on the items at the time of use based upon either the purchase price or the fair market rental value for the period of time used.

I understand that it is a criminal offense to give a resale certificate to the seller for taxable items that I know, at the time of purchase, are purchased for use rather than for the purpose of resale, lease or rental, and depending on the amount of tax evaded, the offense may range from a Class C misdemeanor to a felony of the second degree.

Purchaser	Title	Date
		

**This certificate should be furnished to the supplier.
Do not send the completed certificate to the Comptroller of Public Accounts.**

Texas Sales and Use Tax Exemption Certification

This certificate does not require a number to be valid.

Name of purchaser, firm or agency	
Address (Street & number, P.O. Box or Route number)	Phone (Area code and number)
City, State, ZIP code	

I, the purchaser named above, claim an exemption from payment of sales and use taxes (for the purchase of taxable items described below or on the attached order or invoice) from:

Seller: _____


Street address: _____ City, State, ZIP code: _____

Description of items to be purchased or on the attached order or invoice:

Purchaser claims this exemption for the following reason:

I understand that I will be liable for payment of all state and local sales or use taxes which may become due for failure to comply with the provisions of the Tax Code and/or all applicable law.

I understand that it is a criminal offense to give an exemption certificate to the seller for taxable items that I know, at the time of purchase, will be used in a manner other than that expressed in this certificate, and depending on the amount of tax evaded, the offense may range from a Class C misdemeanor to a felony of the second degree.

 Purchaser	Title	Date
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NOTE: This certificate cannot be issued for the purchase, lease, or rental of a motor vehicle.

THIS CERTIFICATE DOES NOT REQUIRE A NUMBER TO BE VALID.

Sales and Use Tax "Exemption Numbers" or "Tax Exempt" Numbers do not exist.

This certificate should be furnished to the supplier.

Do not send the completed certificate to the Comptroller of Public Accounts.

VERIFICATION REQUIRED BY TEXAS GOVERNMENT CODE SECTION 2274.002

State law requires verification from a Company for contracts (which includes contracts formed through purchase orders) involving goods or services: (1) between a government entity and a Company with 10 or more full-time employees, and (2) has a value of \$100,000 or more that is to be paid wholly or partly from public funds of the governmental entity.

By signing below, Company hereby verifies the following:

1. Company does not boycott energy companies; and
2. Company will not boycott energy companies during the term of the contract.

PRINT COMPANY NAME: _____

SIGNED BY: _____

Print Name & Title: _____

Date Signed: _____

The following definitions apply to this state statute:

(1) "Boycott energy company" means without an ordinary business purpose, refusing to deal with, terminating business activities with, or otherwise taking any action that is intended to penalize, inflict economic harm on, or limit commercial relations with a company because the company:

(A) engages in the exploration, production, utilization, transportation, sale, or manufacturing of fossil fuel-based energy and does not commit or pledge to meet environmental standards beyond applicable federal and state law; or (B) does business with a company described by Paragraph (A); and

(2) "Company" means a for-profit organization, association, corporation, partnership, joint venture, limited partnership, limited liability partnership, or limited liability company, including a wholly owned subsidiary, majority-owned subsidiary, parent company, or affiliate of those entities or business associations that exists to make a profit.

ATTACHMENT A

VERIFICATION REQUIRED BY TEXAS GOVERNMENT CODE SECTION 2274.002

By signing below, Contractor hereby verifies that Section 2274.002 does not apply to this contract due to the following (check all that apply):

- ☐ Contractor is a sole proprietor; or
- ☐ Contractor has less than 10 full-time employees; or
- ☐ Contract value is for less than \$100,000.00.

PRINT COMPANY NAME: _____

SIGNED BY: _____

Print Name & Title: _____

Date Signed: _____

VERIFICATION REQUIRED BY TEXAS GOVERNMENT CODE SECTION 2274.002

State law requires verification from a Company for contracts (which includes contracts formed through purchase orders) involving goods or services: (1) between a government entity and a Company with 10 or more full-time employees, and (2) has a value of \$100,000 or more that is to be paid wholly or partly from public funds of the governmental entity.

By signing below, Company hereby verifies the following:

1. Company does not have a practice, policy, guidance, or directive that discriminates against a firearm entity or firearm trade association; and
2. Company will not discriminate during the term of the contract against a firearm entity or firearm trade association.

PRINT COMPANY NAME: _____

SIGNED BY: _____

Print Name & Title: _____

Date Signed: _____

The following definitions apply to this state statute:

(1) "Ammunition" means a loaded cartridge case, primer, bullet, or propellant powder with or without a projectile;

(2) "Company" means a for-profit organization, association, corporation, partnership, joint venture, limited partnership, limited liability partnership, or limited liability company, including a wholly owned subsidiary, majority-owned subsidiary, parent company, or affiliate of those entities or business associations that exists to make a profit;

(3) "Discriminate against a firearm entity or firearm trade association":

(A) means, with respect to the entity or association, to:

(i) refuse to engage in the trade of any goods or services with the entity or association based solely on its status as a firearm entity or firearm trade association;

(ii) refrain from continuing an existing business relationship with the entity or association based solely on its status as a firearm entity or firearm trade association; or

(iii) terminate an existing business relationship with the entity or association based solely on its status as a firearm entity or firearm trade association; and

(B) does not include:

(i) the established policies of a merchant, retail seller, or platform that restrict or prohibit the listing or selling of ammunition, firearms, or firearm accessories; and

(ii) a company's refusal to engage in the trade of any goods or services, decision to refrain from continuing an existing business relationship, or decision to terminate an existing business relationship:

(aa) to comply with federal, state, or local law, policy, or regulations or a directive

by a regulatory agency; or

(bb) for any traditional business reason that is specific to the customer or potential customer and not based solely on an entity's or association's status as a firearm entity or firearm trade association;

(4) "Firearm" means a weapon that expels a projectile by the action of explosive or expanding gases;

(5) "Firearm accessory" means a device specifically designed or adapted to enable an individual to wear, carry, store, or mount a firearm on the individual or on a conveyance and an item used in conjunction with or mounted on a firearm that is not essential to the basic function of the firearm. The term includes a detachable firearm magazine;

(6) "Firearm entity" means:

(A) a firearm, firearm accessory, or ammunition manufacturer, distributor, wholesaler, supplier, or retailer; and

(B) a sport shooting range as defined by Section 250.001, Local Government Code;

(7) "Firearm trade association" means any person, corporation, unincorporated association, federation, business league, or business organization that:

(A) is not organized or operated for profit and for which none of its net earnings inures to the benefit of any private shareholder or individual;

(B) has two or more firearm entities as members; and

(C) is exempt from federal income taxation under Section 501(a), Internal Revenue Code of 1986, as an organization described by Section 501(c) of that code.

ATTACHMENT A

VERIFICATION REQUIRED BY TEXAS GOVERNMENT CODE SECTION 2274.002

By signing below, Contractor hereby verifies that Section 2274.002 does not apply to this contract due to the following (check all that apply):

- ☐ Contractor is a sole proprietor; or
- ☐ Contractor has less than 10 full-time employees; or
- ☐ Contract value is for less than \$100,000.00.

PRINT COMPANY NAME: _____

SIGNED BY: _____

Print Name & Title: _____

Date Signed: _____

VERIFICATION REQUIRED BY TEXAS GOVERNMENT CODE SECTION 2271.002

State law requires verification from a Company for contracts (which includes contracts formed through purchase orders) involving goods or services: (1) between a government entity and a Company with 10 or more full-time employees, and (2) has a value of \$100,000 or more that is to be paid wholly or partly from public funds of the governmental entity.

By signing below, Company hereby verifies the following:

1. Company does not boycott Israel; and
2. Company will not boycott Israel during the term of the contract.

PRINT COMPANY NAME: _____

SIGNED BY: _____

Print Name & Title: _____

Date Signed: _____

The following definitions apply to this state statute:

(1) "Boycott Israel" means refusing to deal with, terminating business activities with, or otherwise taking any action that is intended to penalize, inflict economic harm on, or limit commercial relations specifically with Israel, or with a person or entity doing business in Israel or in an Israeli-controlled territory, but does not include an action made for ordinary business purposes; and

(2) "Company" means a for-profit organization, association, corporation, partnership, joint venture, limited partnership, limited liability partnership, or limited liability company, including a wholly owned subsidiary, majority-owned subsidiary, parent company, or affiliate of those entities or business associations that exists to make a profit.

ATTACHMENT A

VERIFICATION REQUIRED BY TEXAS GOVERNMENT CODE SECTION 2271.002

By signing below, Contractor hereby verifies that Section 2271.002 does not apply to this contract due to the following (check all that apply):

- ☐ Contractor is a sole proprietor; or
- ☐ Contractor has less than 10 full-time employees; or
- ☐ Contract value is for less than \$100,000.00.

PRINT COMPANY NAME: _____

SIGNED BY: _____

Print Name & Title: _____

Date Signed: _____



INFORMATION ABOUT FORM 1295 DISCLOSURE

Beginning January 1, 2016, a business entity entering into a contract which is approved by the Waco City Council for services, goods or other property to be used by the City of Waco was required to complete a Certificate of Interested Parties Form 1295 on the Texas Ethics Commission website. A Form 1295 may also be required if a contract with the City is changed, amended, extended, or renewed.

House Bill 1295 found in Texas Government Code Chapter 2252 requires a “business entity” that:

- (1) enters into a contract which must be approved by the Waco City Council
- (2) for services, goods or other property
- (3) to be used by the City of Waco

to complete a Certificate of Interested Parties Form 1295 on the Texas Ethics Commission website. **"Business entity" means any entity recognized by law through which business is conducted, including a sole proprietorship, partnership, or corporation. It includes for-profit and non-profit entities. A contract with an individual is not a contract with a business entity.** A Form 1295 is not required for contracts with a publicly traded business entity, including a wholly owned subsidiary of the business entity.

The Texas Ethics Commission has adopted rules to implement the law and adopted the Certificate of Interested Parties form (Form 1295). The Commission states that it does not have any additional authority to enforce or interpret House Bill 1295 (approved in 2015).

Form 1295 requires disclosure of interested parties (a) who have a controlling interest in a business entity with whom the government entity contracts or (b) who actively participate in facilitating a contract or negotiating the terms of a contract (such as a broker, advisor, or attorney for business entity) if the person receives compensation from the business entity (but is not an employee of the entity) and communicates directly with the governmental entity regarding the contract. A person has a controlling interest if the person: (1) has an ownership interest or participating interest in a business entity by virtue of units, percentage, shares, stock, or otherwise that exceeds 10 percent; (2) has membership on the board of directors or other governing body of a business entity of which the board or other governing body is composed of not more than 10 members; or (3) serves as an officer of a business entity that has four or fewer officers, or serves as one of the four officers most highly compensated by a business entity that has more than four officers.

Filing Process:

The Texas Ethics Commission has made the filing Form 1295 available on its website as an electronic form at: https://www.ethics.state.tx.us/whatsnew/elf_info_form1295.htm

A business entity entering into a contract for services, goods or other property with the City of Waco must use that website application to enter the required information on Form 1295 and then print or download a copy of the form. The printed Form 1295 will have unique certification number assigned by the Commission in the upper right part of the Form. An authorized agent of the business entity must sign a printed copy of the Form. The executed Form 1295 must be filed with the City of Waco. The form can be scanned and emailed to the City, faxed to the City, mailed to the City, or delivered to the City. The City is then required to notify the Commission using the Commission’s website that the Form 1295 has been received by the City. The information from the completed Form 1295 will then be posted on the Commission’s website.

PROCEDURE TO PROTEST AWARD RECOMMENDATION

- A. If a firm or person believes it is injured as a result of an RFB, a written protest may be filed.
- B. The written protest may be delivered to the City's Purchasing Services Department ("Purchasing") in person to the department offices located at **1415 N. 4th St., Waco, Texas, 76707**, or by certified mail, return receipt requested, to the following address:

Purchasing Services c/o City of Waco
Post Office Box 2570
Waco, Texas 76702-2570
- C. The written protest must be filed no later than 5:00 p.m. on the fifth (5th) business day from the date of receipt of notification of the recommendation for the contract award.
- D. The written protest must include the following information before it may be considered:
 - 1. Name, mailing address, and business phone number of the protesting party;
 - 2. Identification of the RFB being protested;
 - 3. A precise and concise statement of the reason(s) for the protest which should provide enough factual information to enable a determination of the basis of the protest; and
 - 4. Any documentation or other evidence supporting the protest.
- E. In conjunction with the department that requested the RFB, Purchasing will attempt to resolve the protest, which may at Purchasing's discretion include meeting with the protesting party. If the protest is successfully resolved by mutual agreement, written verification of the resolution of each ground addressed in the protest will be provided to the city manager or designee assistant city manager.
- F. If the Purchasing is unable to resolve the protest, the protesting party may request the protest be reviewed and resolved by the city manager or designee assistant city manager.
- G. A request for the city manager's review must be in writing and received by the Purchasing within three (3) business days from the date the Purchasing informs the protesting party the protest cannot be resolved. The request for review must be delivered in person to the Purchasing at the address stated above or by certified mail, return receipt requested, to the mailing address stated above.
- H. If a protesting party fails or refuses to request a review by the city manager within the three (3) days, the protest is deemed finalized and no further review by the city is required.
- I. Applicable documentation and other information applying to the protest may be submitted by the protesting party to the Purchasing before review by the city manager. If the protesting party requests a review by the city manager, such documentation will be forwarded to the city manager or designee assistant city manager for consideration. The city manager or designee assistant city manager may likewise notify the protesting party or any city department to provide additional information. The decision reached by the city manager or designee assistant city manager will be final, but the protesting party may still appear before the City Council during the Hearing of the Visitors session of a City Council meeting.

SAMPLE CONTRACT

A sample contract is being provided for information purposes so that the Bidder will be familiar with the possible form of the contract. The City of Waco reserves the right to revise this contract form.

SAMPLE

CONTRACT

THIS CONTRACT ("the Contract"), made this ____ day of _____, 2021, by and between **CITY OF WACO**, herein called "Owner" acting herein through its City Manager or Assistant City Manager, and _____, of _____, herein called "Contractor".

WITNESSETH: that for and in consideration of the payments and agreements hereinafter mentioned, to be made and performed by the OWNER, the CONTRACTOR hereby agrees with the OWNER to commence and complete the construction and repair work for the **City of Waco Convention Center HVAC Changeout – Phase 2**, hereinafter called the Project, for the sum of _____ (\$ _____) and all extra work in connection therewith, and at his (its or their) own proper cost and expense to furnish all the materials, supplies, machinery, equipment, tools, superintendence, labor, insurance, and other accessories and services necessary to complete the said Project in accordance with the Contract Documents. The Contract Documents consist of the following:

1. This Contract;
2. Permits and licenses from other agencies as may be required by law;
3. The Specifications/Plans which consist of:
 - a. Specifications prepared by the City of Waco/GTX Engineering.
 - b. City of Waco Standard Specifications for Construction" dated 2013, as revised by Special Provisions listed on the City of Waco website at <http://www.waco-texas.com/engineering-specifications.asp> ("Standard Specifications"); and
 - c. City of Waco, Texas – Manual of Standard Details revised April 15, 2015, (also referred to as "Standard Plans" in the Standard Specifications), the Special Project Provisions, and the Plans (as defined in the Standard Specifications); and
4. Addenda to the RFB (if any);
5. All documents included in RFB No. 2022-091
6. Contractor's Bid;
7. Required bonds;
8. Reference Specifications (as defined in the Standard Specifications);
9. Change Directives and Change Orders (as defined in the Standard Specifications);
10. All Modifications issued after the execution of the Agreement; and
11. Any other drawings and printed or written explanatory matter.

The Contractor hereby agrees to commence work under this Contract on or before a

Contract

Page 2

date to be specified in a written "Notice to Proceed" of the Owner and to fully complete the Project within **100 CALENDAR days** thereafter and perform the work in accordance with the Contract Documents. The Contractor further agrees to pay, as liquidated damages, the sum of **\$500.00** for each CALENDAR Day thereafter as provided in Section 7.8 of the General Provisions of the Standard Specifications.

The **OWNER** agrees to pay the **CONTRACTOR** in current funds for the performance of the contract, subject to additions and deductions, as provided in Section 4 of the City of the General Provisions of the Standard Specifications.

IN WITNESS WHEREOF, the parties to these presents have executed this contract, in the year and day first above mentioned.

CITY OF WACO, TEXAS

BY: _____
Bradley Ford, City Manager

APPROVED AS TO FORM & LEGALITY

Breanne Daniels, Assistant City Attorney

APPROVED:

(Corporate Seal)

CONTRACTOR

ATTEST/WITNESS:

By: _____

Title: _____

Corporate Secretary or Witness

Address: _____

Note: If Contractor is a corporation, corporate secretary should attest.
entities, a witness should sign.

For other types of

Performance Bond

Bond No. _____

PERFORMANCE BOND

Required by City of Waco where contract is over \$100,000

STATE OF TEXAS
COUNTY OF McLENNAN

KNOW ALL BY THESE PRESENTS: That we (1) _____
 _____, (2) a _____ of (3) _____
 hereinafter called **Principal** and (4) _____
 _____ of _____, State of _____,
 which is duly authorized to do business in the State of Texas and is hereinafter called **Surety**, are
 held and firmly bound unto City of Waco of McLennan County, Texas in the amount of _____
 _____ Dollars
 (\$ _____) in lawful money of the United States, to be paid in McLennan
County, Texas, for the payment of which sum well and truly to be made, we bind ourselves, our
 heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into
 a certain contract with City of Waco dated the (5) _____ day of _____,
 A.D., 20____, a copy of which is hereto attached and make a part hereof for the construction of:

- | |
|--|
| (1) Correct legal name of Contractor
(2) A Corporation, a Partnership, Limited Liability Company or an Individual, whatever the business entity form
(3) City and state of contractor's office
(4) Correct name of Surety along with city and state
(5) Leave dates blank. City will fill in with date of City Council action. |
|--|

NOW THEREFORE, if the Principal shall well, truly and faithfully perform the work in
 accordance with the plans, specifications and contract documents during the original term
 thereof, and any extensions thereof which may be granted by the City of Waco, with or without
 notice to the Surety, and if Principal shall fully satisfy all claims and demands incurred under
 such contract, and shall fully indemnify and save harmless the City of Waco from all costs and
 damages which it may suffer by reason of failure to do so, and shall reimburse and repay the
 City of Waco all outlay and expense which the City of Waco may incur in making good any
 default, then this obligation shall be void. Otherwise, this obligation remains in full force and
 effect.

For value received, Surety hereby stipulates and agrees that no change, extension of
 time, alteration or addition to the terms of the Contract or to the work performed thereunder, or
 the plans, specifications, drawings, etc. accompanying same, with or without notice to Surety,
 shall in any way affect its obligation on this Bond; and it does hereby waive notice of any such
 change, extension of time, alteration or addition to the terms of the Contract or to the work to be
 performed thereunder.

Performance Bond

Surety's telephone number is (_____) _____. Any notice of claim shall be sent to Surety at:

Mailing address: _____

Address of surety company: _____.

IN WITNESS WHEREOF, this instrument is executed, this the ____ day of _____, A.D. 20____.

NOTE: Date of Bond must NOT be prior to date of Contract or date of Council action, whichever is later.

ATTEST:

(Principal) Secretary

Principal - Contractor*

(Corporate Seal)

BY: _____

Witness as to Principal

Title: _____

Address: _____

Address: _____

ATTEST:

(Surety) Secretary

Surety

(Surety Seal)

BY: _____

Attorney-in-Fact

Witness to Surety

Address: _____

Address: _____

*If Contractor is Partnership, all partners should execute bond. Use extra pages if necessary.

Form 09/22/2016

Bond No. _____

PAYMENT BOND

Required by City of Waco where contract is over \$50,000

THE STATE OF TEXAS
COUNTY OF McLENNAN

KNOW ALL MEN BY THESE PRESENTS: That we (1) _____
 (2) _____ of (3) _____ hereinafter called
 Principal and (4) _____
 _____ of _____, State of _____
 _____, which is duly authorized to do business in the State of Texas and is hereinafter called
 Surety, are held and firmly bound unto THE CITY OF WACO of McLENNAN COUNTY, TEXAS,
 and unto all persons, firms, and corporations, who may furnish materials for, or perform labor upon
 the building or improvements hereinafter referred to in the amount of

_____ Dollars
 (\$ _____) in lawful money of the United States, to be paid in McLENNAN
COUNTY, TEXAS, for the payment of which sum well and truly to be made, we bind ourselves,
 our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that whereas, the Principal entered into a
 certain contract with THE CITY OF WACO dated the (5) _____ day _____, A.D.,
 20____, a copy of which is hereto attached and made a part hereof for _____
 _____ (herein called the "Work").

- (1) Correct name of Contractor
- (2) A Corporation, a Partnership, Limited Liability Company or an Individual, whatever the business entity form
- (3) City and state of contractor's office
- (4) Correct name of Surety along with city and state
- (5) Leave dates blank. City will fill in with date of City Council action.

NOW, THEREFORE, the condition of this obligation is such that, if the Principal shall promptly make payment to all payment bond beneficiaries as defined in Chapter 2253 of the Texas Government Code, supplying labor and materials in the prosecution of the work provided for in said Contract, then this obligation shall be null and void; otherwise the obligation shall remain in full force and effect.

The Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the Work to be performed under the Contract, with or without notice to Surety, shall in any way affect its obligation on this Bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the Work to be performed under the Contract.

The Surety agrees to pay the City of Waco upon demand all loss and expense, including attorney's fees and court costs, incurred by the City of Waco by reason of or on account of any breach of this obligation by the Surety.

Payment Bond

This bond is made for and entered into solely for the protection of all payment bond beneficiaries supplying labor and materials in the prosecution of the work provided for in said contract, and all such payment bond beneficiaries shall have a direct right of action under the bond as provided in Chapter 2253 of the Texas Government Code.

PROVIDED FURTHER, that no final settlement between the City of Waco and the Contractor shall abridge the right of any beneficiary hereunder, whose claim may be unsatisfied.

Surety's telephone number is (_____) _____. Any notice of claim shall be sent to Surety at:

Mailing address: _____

Address of surety company: _____

IN WITNESS WHEREOF, this instrument is executed, this the _____ day of _____, A.D. 20____.

NOTE: Date of Bond must NOT be prior to date of Contract or date of Council action, whichever is later.

ATTEST:

(Principal) Secretary

(Corporate Seal)

Witness as to Principal

Address: _____

ATTEST:

(Surety) Secretary

(Surety Seal)

Witness to Surety

Address: _____

Principal - Contractor*

BY: _____

Title: _____

Address: _____

Surety

BY: _____

Attorney-in-Fact

Address: _____

*If Contractor is Partnership, all partners should execute bond. Use extra pages if necessary.

APPENDIX C

Forms to Complete and Return

- (1) Submission of Bid/Proposal and Acknowledgment of Addenda
- (2) Business Identification Form
- (3) Conflict of Interest Questionnaire (CIQ form)
- (4) Disclosure of Relationships with City Council/Officers (City Charter)
- (5) Minority/Women Owned Business
- (6) Litigation Disclosure
- (7) Certification Regarding Debarment
- (8) Non-collusion Affidavit
- (9) Resident Certification
- (10) Texas Public Information Act
- (11) Drug Free Workplace



SUBMISSION OF BID AND ACKNOWLEDGMENT OF ADDENDA RFB No. 2022-091

ISSUED BY CITY OF WACO, TX

The entity identified below hereby submits its response to the above identified RFB. The entity affirms that it has examined and is familiar with all of the documents related to RFB.

DECLARATION OF INTENT

As per the "SUBSTITUTIONS" section of the "STANDARD INSTRUCTIONS FOR ALL BIDS" contained within these bid documents, I attest that the bid submitted is: (check one box below)

- ☐ 1. to the exact Specifications and the Terms and Conditions of the bid documents.
- ☐ 2. to the exact specifications with modifications to the Specifications and/or the Terms and Conditions as noted in the attached documentation.
- or
- ☐ 3. NOT to the exact Specifications and/or the Terms and Conditions and is therefore an alternate bid, submitted for the City's consideration, with attached justification(s) and documentation defending the alternate bid as meeting or exceeding the intent of the specifications or scope of work.

Submitter further acknowledges receipt of the following addenda:

Addendum No ____ issued _____

Addendum No ____ issued _____

Addendum No ____ issued _____

Addendum No ____ issued _____

Addendum No ____ issued _____

Addendum No ____ issued _____

Date: _____

Proposal of (entity name) _____

Signature of Person Authorized
to Sign Submission: _____

Signor's Name and Title
(print or type): _____

PLEASE SIGN AND RETURN WITH BID



BUSINES ENTITY IDENTIFICATION

To identify the appropriate person to execute documents, please fill in this form:

Full Legal Name of Business Entity: _____

Doing Business As (assumed name): _____

Main Contact Person: _____

Registered Office Address: _____

Business Phone #: _____ Fax#: _____

Email Address: _____ DUNS Number: _____

Check the appropriate box to designate the type of business entity and complete the information below.

Is entity: ☐ Sole Proprietorship ☐ Corporation ☐ Professional Corporation
☐ General Partnership ☐ Limited Partnership ☐ Limited Liability Partnership
☐ Limited Liability Company ☐ Professional Limited Liability Company
☐ Other _____

Date Business Started: _____ State Where Started: _____

If the entity was formed in another state, registration with the Texas Secretary of State may be required before transacting business in Texas. See http://www.sos.state.tx.us/corp/foreign_outofstate.shtml

Publicly traded company ☐ No ☐ Yes – Where Traded: _____

Depending on the type of business entity, the business will have owners, corporate officers, corporate directors, partners, managers, members, etc. Complete the information below -

To provide information on more than one person or entity for boxes 1 to 5, please use back of page, blank page, or another copy of this form.

1	Name of Primary Officer, Partner, Owner, Manager, Member, Director	
2	Position or title with business entity	
3	Address <i>(if different from above)</i>	
4	Who is authorized to execute contracts and other documents?	
5	What is the title or position of the person listed in #4?	
6	Please provide a document (resolution, bylaw, agreement, etc.) that states the person identified in #4 has authority to execute contracts or execute affidavit.	

In signing this form, I acknowledge that I have read the above and state that the information contained therein is true and correct.

Signature: _____ Date: _____

Print Name: _____ Print Title: _____

ESTABLISHING AUTHORITY TO EXECUTE CONTRACT

When an instrument is signed on behalf of a business entity, documentation must be submitted that states the person signing on behalf of the business entity has the authority to do so. That documentation may be in the form of a resolution approved by a corporate board of directors, charter provisions, by-laws, partnership agreement, etc.

If a business entity has a document authorizing one or more individuals to enter into contracts or execute any instrument in the name of the business entity that it may deem necessary for carrying on the business of the entity, a certified copy of that document may be submitted.

If the business has a document stating who can execute documents for the business (such as a corporate resolution, charter provision, corporate bylaw, etc), the certification below may be signed and that document attached to this page.

CERTIFICATION REGARDING ATTACHED DOCUMENT

I, the undersigned person, as the *{title}* _____ of
{business entity} _____, certify that the attached
 document authorizes *[name of person]* _____ to execute
 contracts and other documents on behalf of said business entity and said document has not been revoked,
 altered, or amended and is still in full force and effect.

SIGNED this _____ day of _____, 20_____

 (Signature)

 Print Name

Attach Document to this Form

If a corporation does not have a document authorizing someone to execute contracts on behalf of the corporation, this resolution form may be used to establish that authority.

RESOLUTION FOR CORPORATION

BE IT RESOLVED by the Board of Directors of _____
(Name of Corporation)

that _____ is hereby authorized to execute a contract with the
(Name)

City of Waco to complete/construct _____
(Name of Project, Project No.)

_____, Secretary is authorized to attest he signature binding the corporation.

(Corporate Seal)

Corporate Name

By: _____

Title: _____

ATTEST:

Secretary of Corporation

CERTIFICATION

I, _____, certify that the above resolution was
(Secretary of Corporation)

adopted by the Board of Directors of _____
(Corporation)

at a meeting on the _____ day of _____, 20__.

(Signature of Secretary)

(Print Name of Secretary)

(Email Address)

If business entity has no document declaring who has authority to execute a contract on behalf of a business entity, this affidavit must be completed.

AFFIDAVIT OF AUTHORITY TO SIGN FOR COMPANY, CORPORATION OR PARTNERSHIP

Name of Business Entity: _____

Which is: ☐ Corporation ☐ Professional Corporation ☐ General Partnership
☐ Limited Partnership ☐ Limited Liability Partnership ☐ Limited Liability Company
☐ Professional Limited Liability Company

On behalf of the above named business entity, I, the undersigned, certify and affirm that the following named person has authority to execute contracts and other documents on behalf of said business entity:

Name: _____

Title: _____

I declare under penalty of perjury that the above is true and correct.

Signature

Print Name

Print Title

STATE OF _____
COUNTY OF _____

SWORN TO AND SUBSCRIBED BEFORE ME this _____ day of _____, A.D., 20____.

(seal)

Notary Public

My Commission Expires:



INSTRUCTIONS FOR CONFLICTS OF INTEREST QUESTIONNAIRE [Form CIQ]

Chapter 176 of the Texas Local Government Code requires vendors who wish to conduct business or be considered for business with a city to file a “conflict of interest questionnaire.” The Texas Ethics Commission (TEC) created the conflict of interest questionnaire (Form CIQ).

Who must complete and filed CIQ form?

Every vendor doing business with the City or seeking to do business with the City must complete Box 1 and sign and date in Box 7. Whether or not a conflict exists determines the other information to include on the form.

Who is a vendor?

The term “vendor” includes a partnership, corporation or other legal entities, including those performing professional services. Partnerships or corporations act through individuals, but it is the partnership or corporation that is doing business with or seeking to do business with the City.

If the vendor seeking to do business with the City is a sole proprietorship, then just the name of the person who is the vendor is needed.

What triggers the requirement to file the Form CIQ?

When a vendor (or an agent of the vendor) begins (1) contract discussions or negotiations with the city or (2) submits an application, quote, response to request for proposals or bids, or anything else that could result in an agreement (contract or purchase order) with the City, Form CIQ must be completed. Whether the vendor initiates the discussion or the City initiates the discussions, Form CIQ must be completed. The monetary amount or value of the contract/purchase does not matter. The contract or purchase may involve the sale or purchase of property, goods, or services with the City of Waco

When does a conflict requiring disclosure exist? What has to be revealed?

- A vendor shall file a completed conflict of interest questionnaire if the vendor has a business relationship with the City of Waco and the vendor:
 - (1) has an employment or other business relationship with an officer of the City of Waco, or a family member of an officer, that results in taxable income exceeding **\$2,500** during the 12 month period preceding the date a contract/purchase is executed or a contract/purchase is being considered; or
 - (2) has given an officer of the City of Waco, or a family member of an officer, one or more gifts with the aggregate value of more than **\$100** in the 12 month period preceding the date a contract/purchase is executed or a contract/purchase is being considered
 - (3) has a family relationship with an officer of the City of Waco.

What family relationships create a conflict?

A “family member” is a person related to another person within the first degree by consanguinity (blood) or affinity (marriage), as described by Subchapter B, Chapter 573, Texas Government Code. The ending of a marriage by divorce or the death of a spouse ends relationships by affinity created by that marriage unless a child of that marriage is living, in which case the marriage is considered to continue as long as a child of that marriage lives.

“Family relationship” means a relationship between a person and another person within the third degree by consanguinity or the second degree by affinity, as those terms are defined by Subchapter B, Chapter 573, Texas Government Code.

Who are officers of the City of Waco?

Officers are the members of the Waco City Council, the City Manager, and any agent or employee who exercises discretion in the planning, recommending, selecting, or contracting with a vendor. An agent may include engineers and architects, as well as others, who assist the City is making a decision on some contract or purchase.

When must a vendor file the conflict of interest questionnaire?

No later than seven days after the date the vendor: (a) begins contract discussions or negotiations with the city, or (b) submits an application or response to a request for proposals or bids, correspondence, or another writing related to a potential agreement with a city, or (c) becomes aware of an employment or other business relationship with an officer or family member of the officer that the vendor (i) has made one or more gifts of more than \$100 or (ii) has a family relationship with.

How do I go about filling out the Conflict of Interest Questionnaire form?

Section 1: Fill in the full name of the **person or company** who is trying to do business with the City. If the “person” is a corporation, partnership, etc., then it is the name of that corporation, partnership, etc., that is required on Form CIQ. If a sole proprietorship, then just the name of the individual is needed. If the “person” is an individual acting as an agent for some other person or a company, then it is the agent’s name. **Any time an agent is involved, two FORM CIQs must be completed and submitted:** one for the agent, and one for the person or company that the agent acted for. The agent’s FORM CIQ must note the vendor that the agent acted for.

Section 2: Check box if the form is an update to a form previously completed. Updates are required by the 7th business day after an event that makes a statement in a previously filed questionnaire incomplete or inaccurate. Updates are also required by September 1 of each year in which the person submits a proposal, bid or response to the City of Waco or begins contract discussions or negotiations with the City.

Section 3: Insert the name of the City of Waco officer with whom there is an affiliation to or business relationship. If there is more than one City officer with whom there is an affiliation or business relationship, a separate form should be completed for each officer.

Section 4: Check the “Yes” or “No” box in Section 4 A or B.

4.A: State whether the officer named on the form receives or is likely to receive taxable income, other than investment income, from the vendor filing the questionnaire.

4.B: State whether the vendor receives or is likely to receive taxable income, other than investment income, from or at the direction of the officer named on the form AND the taxable income is not received from the City.

Section 5: Describe each employment or business relationship with the local government officer named on the form.

Section 6: Check box to acknowledge gifts made that require disclosure.

Section 7. Person completing form must date and sign the form. If the form is being completed for a corporation, partnerships, etc., the person signing should be someone who is authorized to act on behalf of the corporation, partnership, etc.

A signature is required in box #4 regardless of any other entry on the form. A copy of

Chapter 176 of the Texas Local Government Code can be found at:

<http://www.statutes.legis.state.tx.us/SOTWDocs/LG/htm/LG.176.htm>

CONFLICT OF INTEREST QUESTIONNAIRE**FORM CIQ****For vendor doing business with local governmental entity****This questionnaire reflects changes made to the law by H.B. 23, 84th Leg., Regular Session.**

This questionnaire is being filed in accordance with Chapter 176, Local Government Code, by a vendor who has a business relationship as defined by Section 176.001(1-a) with a local governmental entity and the vendor meets requirements under Section 176.006(a).

By law this questionnaire must be filed with the records administrator of the local governmental entity not later than the 7th business day after the date the vendor becomes aware of facts that require the statement to be filed. See Section 176.006(a-1), Local Government Code.

A vendor commits an offense if the vendor knowingly violates Section 176.006, Local Government Code. An offense under this section is a misdemeanor.

OFFICE USE ONLY

Date Received

This includes the vendor name even if a conflict does not exist

1 Name of vendor who has a business relationship with local governmental entity.

Insert name of vendor seeking to do business with the City of Waco

2 Check this box if you are filing an update to a previously filed questionnaire. (The law requires that you file an updated completed questionnaire with the appropriate filing authority not later than the 7th business day after the date on which you became aware that the originally filed questionnaire was incomplete or inaccurate.)

3 Name of local government officer about whom the information is being disclosed.

Insert name of officer with whom there is business, employment or family relationship. If no conflict, insert N/A.

Name of Officer

4 Describe each employment or other business relationship with the local government officer, or a family member of the officer, as described by Section 176.003(a)(2)(A). Also describe any family relationship with the local government officer. Complete subparts A and B for each employment or business relationship described. Attach additional pages to this Form CIQ as necessary.

Complete A-B if a conflict exist

A. Is the local government officer or a family member of the officer receiving or likely to receive taxable income, other than investment income, from the vendor?

☐ Yes

☐ No

B. Is the vendor receiving or likely to receive taxable income, other than investment income, from or at the direction of the local government officer or a family member of the officer AND the taxable income is not received from the local governmental entity?

☐ Yes

☐ No

5 Describe each employment or business relationship that the vendor named in Section 1 maintains with a corporation or other business entity with respect to which the local government officer serves as an officer or director, or holds an ownership interest of one percent or more.

Identify and describe the relationship, if applicable

6 ☐ Check this box if the vendor has given the local government officer or a family member of the officer one or more gifts as described in Section 176.003(a)(2)(B), excluding gifts described in Section 176.003(a-1).

7 Signature required -- so sign and date, even if no conflict

Signature of vendor doing business with the governmental entity _____ Date _____

CONFLICT OF INTEREST QUESTIONNAIRE

For vendor doing business with local governmental entity

A complete copy of Chapter 176 of the Local Government Code may be found at <http://www.statutes.legis.state.tx.us/Docs/LG/htm/LG.176.htm>. For easy reference, below are some of the sections cited on this form.

Local Government Code § 176.001(1-a): "Business relationship" means a connection between two or more parties based on commercial activity of one of the parties. The term does not include a connection based on:

- (A) a transaction that is subject to rate or fee regulation by a federal, state, or local governmental entity or an agency of a federal, state, or local governmental entity;
- (B) a transaction conducted at a price and subject to terms available to the public; or
- (C) a purchase or lease of goods or services from a person that is chartered by a state or federal agency and that is subject to regular examination by, and reporting to, that agency.

Local Government Code § 176.003(a)(2)(A) and (B):

(a) A local government officer shall file a conflicts disclosure statement with respect to a vendor if:

(2) the vendor:

(A) has an employment or other business relationship with the local government officer or a family member of the officer that results in the officer or family member receiving taxable income, other than investment income, that exceeds \$2,500 during the 12-month period preceding the date that the officer becomes aware that

(i) a contract between the local governmental entity and vendor has been executed;
or

(ii) the local governmental entity is considering entering into a contract with the vendor;

(B) has given to the local government officer or a family member of the officer one or more gifts that have an aggregate value of more than \$100 in the 12-month period preceding the date the officer becomes aware that:

(i) a contract between the local governmental entity and vendor has been executed; or

(ii) the local governmental entity is considering entering into a contract with the vendor.

Local Government Code § 176.006(a) and (a-1)

(a) A vendor shall file a completed conflict of interest questionnaire if the vendor has a business relationship with a local governmental entity and:

(1) has an employment or other business relationship with a local government officer of that local governmental entity, or a family member of the officer, described by Section 176.003(a)(2)(A);

(2) has given a local government officer of that local governmental entity, or a family member of the officer, one or more gifts with the aggregate value specified by Section 176.003(a)(2)(B), excluding any gift described by Section 176.003(a-1); or

(3) has a family relationship with a local government officer of that local governmental entity.

(a-1) The completed conflict of interest questionnaire must be filed with the appropriate records administrator not later than the seventh business day after the later of:

(1) the date that the vendor:

(A) begins discussions or negotiations to enter into a contract with the local governmental entity; or

(B) submits to the local governmental entity an application, response to a request for proposals or bids, correspondence, or another writing related to a potential contract with the local governmental entity; or

(2) the date the vendor becomes aware:

(A) of an employment or other business relationship with a local government officer, or a family member of the officer, described by Subsection (a);

(B) that the vendor has given one or more gifts described by Subsection (a); or

(C) of a family relationship with a local government officer.

CONFLICT OF INTEREST QUESTIONNAIRE

For vendor doing business with local governmental entity

FORM CIQ

This questionnaire reflects changes made to the law by H.B. 23, 84th Leg., Regular Session.

This questionnaire is being filed in accordance with Chapter 176, Local Government Code, by a vendor who has a business relationship as defined by Section 176.001(1-a) with a local governmental entity and the vendor meets requirements under Section 176.006(a).

By law this questionnaire must be filed with the records administrator of the local governmental entity not later than the 7th business day after the date the vendor becomes aware of facts that require the statement to be filed. See Section 176.006(a-1), Local Government Code.

A vendor commits an offense if the vendor knowingly violates Section 176.006, Local Government Code. An offense under this section is a misdemeanor.

OFFICE USE ONLY

Date Received

1 Name of vendor who has a business relationship with local governmental entity.

2 Check this box if you are filing an update to a previously filed questionnaire. (The law requires that you file an updated completed questionnaire with the appropriate filing authority not later than the 7th business day after the date on which you became aware that the originally filed questionnaire was incomplete or inaccurate.)

3 Name of local government officer about whom the information is being disclosed.

Name of Officer

4 Describe each employment or other business relationship with the local government officer, or a family member of the officer, as described by Section 176.003(a)(2)(A). Also describe any family relationship with the local government officer. Complete subparts A and B for each employment or business relationship described. Attach additional pages to this Form CIQ as necessary.

A. Is the local government officer or a family member of the officer receiving or likely to receive taxable income, other than investment income, from the vendor?

☐ Yes

☐ No

B. Is the vendor receiving or likely to receive taxable income, other than investment income, from or at the direction of the local government officer or a family member of the officer AND the taxable income is not received from the local governmental entity?

☐ Yes

☐ No

5 Describe each employment or business relationship that the vendor named in Section 1 maintains with a corporation or other business entity with respect to which the local government officer serves as an officer or director, or holds an ownership interest of one percent or more.

6 ☐ Check this box if the vendor has given the local government officer or a family member of the officer one or more gifts as described in Section 176.003(a)(2)(B), excluding gifts described in Section 176.003(a-1).

7

Signature of vendor doing business with the governmental entity

Date



DISCLOSURE OF RELATIONS WITH CITY COUNCIL MEMBER, OFFICER, OR EMPLOYEE OF CITY OF WACO

Failure to fully and truthfully disclose the information required by this form may result in the termination of any business the City is now doing with the entity listed below and/or could impact future dealings.

1. Name of Entity/Business/Person doing business with City: _____

Is the above entity: **(Check one)**

- ☐ A corporation
 ☐ A partnership
 ☐ A sole proprietorship or an individual
 ☐ Other (specify): _____

Check all applicable boxes.

2. Is any person involved as an owner, principal, or manager of name listed in #1 related to or financially dependent on Council member, officer, or employee of the City of Waco?

- ☐ NO -- there is no such relationship between Entity/Business/Person and the City of Waco.
☐ YES, a person who is a/an ☐ owner, ☐ principal, or ☐ manager of this entity/business/person

is: **(Check all applicable boxes below)**

- ☐ related to by blood or marriage* and/or ☐ a member of the same household as
 and/or ☐ financially dependent upon** and/or ☐ financially supporting**
 to a City of Waco ☐ City Council member, ☐ officer or ☐ employee.

* As used here, "related to" means a spouse, child or child's spouse, and parent or parent's spouse. It also includes a former spouse if a child of that marriage is living (the marriage is considered to continue as long as a child of that marriage lives).

** As used herein, "financially dependent upon" and "financially supporting" refers to situations in which monetary assistance—including for lodging, food, education, and debt payments—is provided by owner, principal or manager of #1 to Council member, officer or employee of City of Waco, or that Council member, officer or employee of City of Waco provides to owner, principal or manager of #1.

If YES, provide (a) the name of owner, principal, or manager, **and** (b) the name of the City Council member, officer or employee (include the department the City officer or employee works for, if known), **and** (c) if a relationship by marriage or by blood/kinship exists. (Use back of sheet if more space is needed)

(a) Name of owner, principal, or manager	(b) Name of Council member, officer or employee & department	(c) What is relationship or household arrangement

3. Is a current City Council member or City employee involved with the name listed in #1 as an owner, principal, manager, or employee, or employed as a contractor for name listed in #1?

- ☐ NO (no person involved/working for Entity/Business/Person is Council member, officer or employee of the City).
☐ YES, a person is **(Check all applicable boxes)**

- (a) a current City of Waco ☐ City Council member, ☐ officer or ☐ employee,
 (b) and is ☐ an owner, ☐ a principal, or ☐ a manager of the entity/business/person listed in #1,
 or ☐ an employee or ☐ an independent contractor of the entity/business/person listed in #1.

If YES, provide the name of owner, principal, manager, employee or independent contractor who is a City Council member, officer or employee. Include the department the City officer or employee works for, if known.

Signature: _____ Phone #: _____ Date: _____

Print Name: _____ Print Title: _____



**CITY OF WACO
PURCHASING
MINORITY / WOMEN OWNED BUSINESS CERTIFICATION**

The City of Waco is committed to assuring that all businesses are given prompt, courteous, and equal opportunity to provide goods and services to the City. To achieve this goal, the City Council requests the minority women owned status of each vendor on the City vendor list.

Definition: A Disadvantaged Minority and Woman owned Business Enterprise means a business concern owned and controlled by socially and economically disadvantaged individuals. This means any business concern that (a) is at least 51% owned by one or more socially and economically disadvantaged individuals; or in the case of publicly owned businesses, at least 51% of the stock which is owned by one or more socially or economically disadvantaged individuals; and (b) whose management and daily operations are controlled by one or more other socially and economically disadvantaged individuals who own it. The groups included in this program are Black Americans, Hispanic Americans, Women, Asian Pacific Americans, Service Disabled Veterans, and Native Americans

Certification: Bidder declares a minority and/or women owned business status:

_____ YES _____ NO

If yes, check one of the blocks (indicate male or female):

Black M/F_____; Hispanic M/F_____; Woman_____; Asian M/F_____;

Native American M/F_____; Service Disabled Veteran of 20% or more M/F_____.

HUB certified _____ YES _____ NO

COMPANY NAME: _____

AUTHORIZED SIGNATURE: _____

TITLE: _____

DATE: _____



LITIGATION DISCLOSURE

Failure to fully and truthfully disclose the information required by this Litigation Disclosure form may result in the disqualification of your bid/proposal/qualifications from consideration or termination of the contract, once awarded.

1. Have you or any member of your Firm or Team to be assigned to this engagement ever been indicted or convicted of a felony or misdemeanor greater than a Class C in the last five (5) years?

☐ Yes

☐ No

2. Have you or any member of your Firm or Team been terminated (for cause or otherwise) from any work being performed for the City of Waco or any other Federal, State or Local Government, or Private Entity?

☐ Yes

☐ No

3. Have you or any member of your Firm or Team been involved in any claim or litigation with the City of Waco or any other Federal, State or Local Government, or a Private Entity during the last ten (10) years?

☐ Yes

☐ No

If you have answered “Yes” to any of the above questions, please indicate the name(s) of the person(s), the nature, and the status and/or outcome of the information, indictment, conviction, termination, claim or litigation, as applicable. Any such information should be provided on a separate page, attached to this form and submitted with your bid/proposal/qualifications.



INSTRUCTIONS FOR CERTIFICATION REGARDING
Certification Regarding Debarment, Suspension, Ineligibility, and
Voluntary Exclusion

1. By signing and submitting this proposal and the certification form, the prospective lower tier participant (BIDDER/PROPOSER/SUBRECIPIENT) is providing the certification set out on the following form (or reverse side) in accordance with these instructions.
2. The certifications in this clause are a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant (BIDDER/PROPOSER/ SUBRECIPIENT) knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.
3. The prospective lower tier participant (BIDDER/PROPOSER/SUBRECIPIENT) shall provide immediate written notice to the person to whom this bid/proposal is submitted if at any time the prospective lower tier participant (BIDDER/PROPOSER/SUBRECIPIENT) learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.
4. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.
5. The prospective lower tier participant (BIDDER/PROPOSER/SUBRECIPIENT) agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.
6. The prospective lower tier participant (BIDDER/PROPOSER/SUBRECIPIENT) further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.
7. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the No procurement List.
8. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.
9. Except for transactions authorized under paragraph 5 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

**Purchasing Department**

Post Office Box 2570

Waco, Texas 76702-2570

254 / 750-8060

Fax: 254 / 750-8063

www.waco-texas.com

**CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY,
AND VOLUNTARY EXCLUSION**

Project Name: _____

Location: _____

RFB/RFP #: _____

This certification is required (or may be required) by the federal regulations implementing Executive Order 12549, Debarment and Suspension. The regulations were published as Part VII of the May 26, 1988, *Federal Register* (pages 19160-19211). For further assistance in obtaining a copy of the regulations, contact the City of Waco Purchasing Department.

READ INSTRUCTIONS BEFORE COMPLETING CERTIFICATION

- (1) The prospective lower tier participant (BIDDER/PROPOSER/SUBRECIPIENT) certifies, by submission of this proposal that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal or State department or agency.
- (2) Where the prospective lower tier participant (BIDDER/PROPOSER/SUBRECIPIENT) is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

 Company

 Name and Title of Authorized Representative

 Signature

 Date

STATE OF TEXAS §
§
COUNTY OF _____ §

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RESIDENT CERTIFICATION

Chapter 2252 of the Texas Government Code “CONTRACTS WITH GOVERNMENTAL ENTITY, SUBCHAPTER A. NONRESIDENT BIDDERS”:

In accordance with Chapter 2252 of the Texas Government Code, a governmental entity may not award a governmental contract to a nonresident bidder unless the nonresident underbids the lowest bid submitted by a responsible resident bidder by an amount that is not less than the amount by which a resident bidder would be required to underbid the nonresident bidder to obtain a comparable contract in the state in which the nonresident’s principle place of business is located.

- (1) "Government contract" means a contract awarded by a governmental entity for general construction, an improvement, a service, or a public works project or for a purchase of supplies, materials, or equipment.
- (2) "Governmental entity" means a municipality, county, public school district, or special-purpose district or authority.
- (3) “Nonresident bidder” refers to a person who is not a resident.
- (4) “Resident bidder” refers to a person whose principal place of business is in this state, including a contractor whose ultimate parent company or majority owner has its principal place of business in this state.

I certify that as defined in Texas Government Code, Chapter 2252 that:

☐ Yes, I am a Texas Resident bidder

☐ No, I am not a Texas Resident bidder

COMPANY NAME: _____

PRINTED NAME: _____

SIGNATURE: _____

PLEASE SIGN AND RETURN WITH BID



TEXAS PUBLIC INFORMATION ACT
Steps To Assert Information Confidential or Proprietary

All proposals, data, and information submitted to the City of Waco are subject to release under the Texas Public Information Act ("Act") unless exempt from release under the Act. You are not encouraged to submit data and/or information that you consider to be confidential or proprietary unless it is absolutely required to understand and evaluate your submission.

On each page where confidential or proprietary information appears, you must label the confidential or proprietary information. Do not label every page of your submission as confidential as there are pages (such as the certification forms and **bid sheet with pricing**) that are **not confidential**. It is recommended that each page that contains either confidential or proprietary information be printed on colored paper (such as yellow or pink paper). At a minimum the pages where the confidential information appears should be labeled and the information you consider confidential or proprietary clearly marked.

Failure to label the actual pages on which information considered confidential appears will be considered as a waiver of confidential or proprietary rights in the information.

In the event a request for public information is filed with the City which involves your submission, you will be notified by the City of the request so that you have an opportunity to present your reasons for claims of confidentiality to the Texas Attorney General.

In signing this form, I acknowledge that I have read the above and further state:

☐ The proposal/bid submitted to the City **contains NO confidential information** and may be released to the public if required under the Texas Public Information Act.

☐ The proposal/bid submitted **contains confidential information** which is labeled and which may be found on the following pages: _____

and any information contained on page numbers not listed above may be released to the public if required under the Texas Public Information Act.

Vendor/Proposer Submitting: _____

Signature: _____ Date: _____

Print Name: _____ Print Title: _____

PLEASE SIGN AND RETURN WITH PROPOSAL/BID

Revised 10/15/2012

DRUG-FREE WORKPLACE ACT CERTIFICATION

1. Contractor certifies that he/she will provide a drug-free workplace by:
 - (a) publishing a statement notifying employees that unlawfully manufacturing, distributing, dispensing, possessing or using a controlled substance in Contractor's workplace is prohibited and specifying the actions that will be taken against employees for violation of such prohibition;
 - (b) establishing a drug-free awareness program to inform employees about:
 - (1) the dangers of drug abuse in the workplace;
 - (2) Contractor's policy of maintaining a drug-free workplace;
 - (3) any drug counseling, rehabilitation, and employee assistance programs that are available; and
 - (4) penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;
 - (c) making it a requirement that each employee to be engaged in the performance of the contract be given a copy of the statement required by paragraph (a);
 - (d) notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the contract the employee will:
 - (1) abide by the terms of the statement; and
 - (2) notify City of any criminal drug statute conviction for a violation occurring in the workplace no later than five (5) days after such a conviction;
 - (e) notifying City within ten (10) days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction;
 - (f) taking one of the following actions within thirty (30) days of receiving notice under subparagraph (d)(2) with respect to any employee so convicted:
 - (1) taking appropriate personnel action against such an employee, up to and including termination; or
 - (2) requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a federal, state or local health, law enforcement, or other appropriate agency; and
 - (g) making a good faith effort to continue to maintain a drug-free workplace through implementation of the above paragraphs.
2. Contractor's headquarters is located at the following address. The addresses of all other workplaces maintained by Contractor, if any, are provided on an accompanying list.

Name of Contractor: _____

Street Address: _____

City: _____

County: _____

State: _____ Zip Code: _____

SIGNED BY: _____

Print Name & Title: _____

Date Signed: _____

APPENDIX D

Specifications

- (1) Project Directory
- (2) Plans (Electrical) Seperate File
- (3) Plans (HVAC) Seperate File

ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
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SECTION 000002**PROJECT DIRECTORY**

OWNER: CITY OF WACO, TX
OPERATIONS CENTER
1415 N. 4TH STREET
WACO, TX, 76707

ARCHITECT: John Puhr AIA
ROOT ARCHITECTURE, LLC.
4009 BANISTER LANE #250
AUSTIN, TX 78704

MEP ENGINEER: Jayson Ritch PE
GTX ENGINEERING LCC
PO BOX 1336, SALADO, TEXAS 76571
254.654.3641

END OF SECTION 000002

	PROJECT DIRECTORY 00002	
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ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
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ROOT Architecture LLC. – Austin,
TX

**City of Waco Convention Center HVAC Replacement-
Phase II**

Waco, Texas
ROOT Project No.22128

SECTION 000107

PROFESSIONAL SEALS PAGE



John Puhr, AIA
Texas Reg. No.: 21296
21 OCT 2022



21 OCT 2022



21 OCT 2022

PROFESSIONAL SEALS PAGE
000107

ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
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DOCUMENT 004100**BID FORM**

DATE: []

TO: []

RE: []

Gentlemen:

Pursuant to the Instruction to Bidders, the undersigned has thoroughly examined the Bidding Documents and the Site, understands the work to be done, and hereby proposes to do all the work as provided in the Bidding Documents and subject to the observation and approval of the Owner and Architect, and binds themselves on acceptance of this bid by Owner for performing and completing the said work within the time stated and to furnish all required guarantees for the following prices:

BASE BID

For the construction of the additions to the Waco Convention Center and including all labor, materials, services, and equipment necessary for the completion of the Work as indicated in the construction documents.

The Sum of _____ DOLLARS

ALTERNATES

Alternate No. 1: []

The Sum of _____ DOLLARS

UNIT PRICES

Unit Price No. 1: []

The Sum of _____ DOLLARS

EXTRA WORK FEES

A. The undersigned agrees that for additional work added to the Contract and for extra costs resulting from changes in the work, the allowance for overhead and profit combined shall be in accordance with the following schedule, but in no case shall it exceed a maximum of 15 percent, (Overhead shall include payroll taxes and supervision): For the Contractor, for any work provided by his own forces: 10% of the cost.

A. For the Contractor, for work produced by his subcontractors: 5% of the amount due the subcontractor.

B. The General Contractor shall not be allowed to charge the Owner for "extended overhead" charges relating to change orders or weather delays.

ADDENDA

This will acknowledge receipt of the following addenda which are part of the Bidding Documents:

	BID FORM 004100	
--	----------------------------	--

ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
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Addendum No. _____ Addendum No. _____

Addendum No. _____ Addendum No. _____

Addendum No. _____ Addendum No. _____

OTHER CONDITIONS

The undersigned agrees to the following:

- A. Will furnish all labor and materials as shown and specified.
- B. Will substantially complete the base proposal work (and any alternates selected) by _____, including days lost to inclement weather.
- C. Will start work _____ days after notice of award of contract.
- D. Agrees that it's Bid shall be good and may not be withdrawn for a period of 60 calendar days after the scheduled closing time for receiving bids.
- E. Understands that the Owner reserves the right to reject any or all Bids and to waive any informalities in the Bidding, and to assign the Work to the Bidder who, in the opinion of the Owner, serves the Owner's best interest.
- F. Attests that the bid is submitted without collusion with any other bidder.

BID ACKNOWLEDGMENT

The undersigned affirms that they are duly authorized to execute this contract, that this company, corporation, firm, partnership, or individual has not prepared this bid in collusion with any other bidder, and that the contents of this bid as to prices, terms, or conditions of said bid have not been communicated by the undersigned nor by any employee or agent to any other person engaged in this type of business prior to the official opening of this bid.

Contractor's authorized signature _____ Date _____

Firm Name _____

Address _____

City _____ State _____

Telephone _____ Facsimile _____ Email _____

END OF SECTION

	BID FORM 004100	
--	---------------------------	--

ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
--	--	--

SECTION 004200 - PROPOSAL FORM

The undersigned, having carefully examined the Construction Documents (the Plans, Specs, Addenda), all related material & the proposed project site, hereby propose to furnish all materials, labor, tools & equipment to complete this project in full accordance to the Contract Documents within the time limits & price as follows.

I will perform all the work in this project for the lump sum price of:

BASE PROPOSAL:

_____ Dollars (\$_____.00).

The work shall be completed work within **100** consecutive calendar days. There will be a liquidated damages charge to the Contractor of **\$500** per day for each day the project is not completed beyond this limit.

We acknowledge receipt of the following Addenda: _____.

By the act of submitting a proposal for the proposed contract, the Proposer represents that:

1. The Proposer and all subcontractors the Proposer intends to use have carefully and thoroughly reviewed the drawings, specifications and other construction documents and have found them complete and free from ambiguities and sufficient for the purpose intended.
2. The Proposer and all workers, employees and subcontractors the Proposer intends to use are skilled and experienced in the type of construction represented by the construction contract documents.
3. The proposal figure is based solely upon the construction contract documents and properly issued written addenda and not upon any other written representation.
4. Neither the Proposer nor any of his employees, agents, intended suppliers or subcontractors have relied upon any verbal representations from the Owner, or the Owner's employees or agents including architects, engineers or consultants, in assembling the proposal figure

Respectfully submitted:

Date: _____

(Proposer)

(Address)

By: _____

Title: _____

Phone #: _____

Fax #: _____

E-mail: _____

	PROPOSAL FORM 004200	
--	--------------------------------	--

ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
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SECTION 004336 – LIST OF SUBCONTRACTORS

THIS FORM SHALL BE COMPLETED BY THE GENERAL CONTRACTOR AND SUBMITTED IN ENVELOPE WITH PROPOSAL.

To: City of Waco
Operations Center
1415 N. 4th Street
Waco, Texas 76707

The undersigned submits the following names of subcontractors to be used in performing the contract:

<u>Subcontractor's Work</u>	<u>Subcontractor's Name</u>	<u>MWBE STATUS</u>
		<input type="checkbox"/> YES <input type="checkbox"/> NO

Mechanical

Electrical

Date

(Proposer)

(Address)

By:

Title:

	LIST OF SUBCONTRACTORS 004336	
--	----------------------------------	--

ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
--	--	--

DOCUMENT 007000**GENERAL CONDITIONS****1. GENERAL CONDITIONS**

1. The "General Conditions of the Contract for Construction", AIA Document A201, Sixteenth Edition, 2007, Articles 1 through 15 inclusive, is a part of this Contract, and is available for review from the Architect. The General Conditions and all modifications listed hereinafter shall apply to all various subcontracts and sub subcontractors.
2. Refer to Document 008000 for Supplementary Conditions.

END OF SECTION

	GENERAL CONDITIONS 007000	
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ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
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**DOCUMENT 008000
SUPPLEMENTARY CONDITIONS**

1.1 SUPPLEMENTS

A. The following supplements modify, change, delete from or add to the "General Conditions of the Contract for Construction", AIA Document A201, Sixteenth Edition, 2007. Where any Article of the General Conditions is modified or any Paragraph, Subparagraph or Clause thereof is modified or deleted by these supplements, the unaltered provision of the Article, Paragraph, Subparagraph or Clause shall remain in effect.

1.2 REFERENCE TO DIVISION 1

A. With regard to provisions of General Conditions related to project administrative or work-related requirements of the Contract, some of those paragraphs are modified or deleted from General Conditions, and are specified in Division 1, "General Requirements" of the Specifications.

1.3 ARTICLE 1 GENERAL PROVISIONS

Add the following new paragraphs:

A. 1.1.9 MISCELLANEOUS DEFINITIONS

1. The term "Product" as used in these Contract Documents includes materials, systems, and equipment.

2. The term "provide" as used in this Project Manual means to furnish and install.

B. 1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

Add the following new subparagraphs:

1.2.4 The inter-relation of the Project Manual, the Drawings and the schedules is as follows: The Project Manual determines the quality, nature and setting of the several materials; the Drawings establish the quantities, dimensions and details; and the schedules give the location. The documents are to be considered as one and whatever is called for by any one shall be as binding as if called for by all.

1.2.5 Should the drawings disagree in themselves, or with the Project Manual, or if proprietary information disagrees with performance requirements in either the Drawings or the Project Manual, the better quality or greater quantity of the Work or materials shall be estimated upon, and unless otherwise ordered by the Architect in writing, shall be performed or furnished. Should discrepancies or doubt occur, do not proceed with the Work without clarification from the Architect. Contractor shall request clarification in sufficient time to avoid delays and increases in the contract sum.

1.4.1 ARTICLE 3 CONTRACTOR

A. 3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

Add following sentences to subparagraph 3.2.2:

3.2.2.1 ...If a dimensional discrepancy exists, Contractor shall take field measurements required for proper fabrication and installation of work. Upon commencement of any item of work, Contractor shall be responsible for dimensions related to such item of Work and shall make any corrections necessary to make work properly fit at no additional cost to Owner.

3.2.2.2Before ordering any material or doing any work, Contractor shall verify dimensions and check conditions in order to assure himself that they properly reflect those on the Drawings. Any inconsistency shall be brought to attention of the Architect. In the event that discrepancies occur between ordered material and actual conditions, of which Architect was not notified beforehand, costs to correct such discrepancies shall be borne by Contractor.

B. 3.3 SUPERVISION AND CONSTRUCTION PROCEDURES

Supplement as provided in Division 1.

C. 3.4 LABOR AND MATERIALS

Add the following new paragraph:

3.4.4. After the Contract has been executed, the Owner and the Architect will consider a formal request for the substitution of products in place of those specified only under the conditions set forth in the General Requirements of the Specifications, Division 1. Refer to Division 1 for supplemental information.

D. 3.5 WARRANTY

Supplement as provided in Division 1.

E. 3.8 ALLOWANCES

Supplement as provided in Division 1.

F. 3.10 CONTRACTOR'S CONSTRUCTION SCHEDULES

Supplement as provided in Division 1.

H. 3.12 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

Supplement as provided in Division 1.

	SUPPLEMENTARY CONDITIONS 008000	
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ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
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I. 3.13 USE OF SITE

Supplement as provided in Division 1.

J. 3.14 CUTTING AND PATCHING

Supplement as provided in Division 1.

K. 3.15 CLEANING UP

Supplement as provided in Division 1.

1.5 ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

Add the following new paragraph

6.4 Coordinated construction work under this Contract includes, but not be limited to, providing concealed blocking as noted for attachment of separate contract items in locations necessary for the actual items to be installed. Providing proper dimensional coordination of separate contract supplied items for general construction work and trim that is to meet and/or adjoin Furniture, Fixtures, Equipment and Accessories.

6.5 It is a requirement of the Contractor's work schedule to provide the cooperation, coordination and exchange of information necessary for a timely execution of separate contract work.

1.6 ARTICLE 7 CHANGES IN THE WORK**A. 7.1 GENERAL**

Supplement as provided in Division 1.

Add the following new paragraphs:

7.1.4 Except as provided in this article, no oral statement, or direction of Architect or Owner shall be treated as a Change Order or entitle Contractor to an adjustment to the Contract Sum or the Contract Time.

7.1.5. Unit prices shall be inclusive of all costs including mark-up for overhead and profit and shall be applied to units of measure as defined in the Contract Documents for each category of Work.

1.7 ARTICLE 8 TIME**A. 8.3 DELAYS AND EXTENSIONS OF TIME**

Add the following new paragraphs

8.34 Apart from extension of time, no payment or claim for damages shall be made to Contractor as compensation for damages for any ordinary delays or hindrances from any cause whatsoever in the progress of the Work, notwithstanding whether such delay be avoidable or unavoidable

8.35 In order to claim an inclement weather delay day, Contractor must:

8.36 Document, in writing, that the weather on the particular day was of such nature (rain, wind, snow, ice, and subsequent resultant effects) that it significantly impacted its ability to make progress on critical path work items. Inclement weather delay days will not be granted for weekends or holidays unless Contractor can demonstrate that it had been and intended to work on these days.

8.37 Submit such delay claims on a weekly basis, not more than 7 days following the day of occurrence.

8.38 Summarize the number of days claimed for the entire month accompanying each month's application for payment.

1.8 ARTICLE 9 PAYMENTS AND COMPLETION**A. 9.2 SCHEDULE OF VALUES**

Supplement as provided in Division 1.

B. 9.3 APPLICATIONS FOR PAYMENT

Supplement as provided in Division 1.

Add the following new subparagraph:

9.3.4 Unless otherwise stated in the Owner-Contractor Agreement, the Owner will retain, until Final Payment, 10 percent of the amount due the Contractor on account of progress payments, payable 30 days after Substantial Completion and satisfactory evidence to the owner that all payments, bills, and claims have been paid.

Add following Sub-subparagraphs:

9.3.4.1 Monthly Applications for Payment shall include waivers of liens for all work included in previous month's application for payment. Waiver of Liens for subcontractors and

	SUPPLEMENTARY CONDITIONS 008000	
--	--	--

ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
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materialmen shall be total amount paid prior to previous months' application for payment.

C. 9.5 DECISIONS TO WITHHOLD CERTIFICATION

Add following Sub-subparagraphs to Subparagraph 9.5.1:

.8 Failure to submit written plan indicating action by Contractor to regain time schedule for completion of Work within Contract Time.

.9 Failure to keep record documents current.

D. 9.8 SUBSTANTIAL COMPLETION

Supplement as provided in Division 1.

E. 9.10 FINAL COMPLETION AND FINAL PAYMENT

Add the following new paragraph:

1. In addition to the items listed in 9.10.2, the Contractor shall deliver 4 sets of the following items to the Owner before final payment will be made:
2. Other close-out submittals as specified in Division 1.
3. Project record documents as specified in Division 1.
4. Operations and maintenance data as specified in Division 1.
5. All warranties as required on specific products or portions of the Work, in format outlined in Division 1.
6. Spare parts, overages, and maintenance materials as outlined in Division 1 and described in the various technical sections.
7. Certificates of occupancy.
8. Copies of all inspection tags from authorities having jurisdiction.
9. Executed Certificate of Substantial Completion.

1.9 ARTICLE 11 INSURANCE AND BONDS

A. 11.1 CONTRACTOR'S LIABILITY INSURANCE

Add the following new Sub-subparagraphs:

11.1.5 Liability insurance shall include all major divisions of coverage and be on a comprehensive basis including:

1. Premises Operations (including X-C-U).
2. Independent Contractor's Protective.
3. Products and Completed Operations.
4. Contractual including specified provisions for the Contractor's obligations under Paragraph
5. Broad Form Property Damage including Completed Operations.
6. Personal Injury Liability with Employment Exclusion Deleted.
7. Owner's and Contractor's Protective.
8. Excess Umbrella.

11.1.6 Insurance certificate(s) shall specify Owner as the certificate holder and (except for Workers' Compensation) as an additional insured.

1.10 ARTICLE 13 MISCELLANEOUS PROVISIONS

A. 13.5 TESTS AND INSPECTIONS

Supplement as provided in Division 1.

END OF DOCUMENT

	SUPPLEMENTARY CONDITIONS 008000	
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SECTION 011000**SUMMARY**

1. GENERAL
1. RELATED DOCUMENTS
 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
2. SUMMARY
 1. Section Includes:
 1. Project information.
 2. Work covered by Contract Documents.
 3. Access to site.
 4. Specification and drawing conventions.
3. PROJECT INFORMATION
 1. Project Identification: City of Waco Convention Center HVAC Replacement- PHASE II
 1. Project Location: 100 Washington Avenue, Waco, TX 76701
 2. Owner: City of Waco, TX.
 1. **Owner's Contacts:**
 3. Architect: John Puhr, AIA
 4. Contractor: TBD
4. WORK COVERED BY CONTRACT DOCUMENTS
 1. The Work of Project is defined by the Contract Documents and consists of the following:
 1. Mechanical and Electrical Drawings for the purpose of updating roof top equipment
 2. Type of Contract:
 1. Project will be constructed under a single prime contract.
5. SPECIFICATION AND DRAWING CONVENTIONS
 1. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
 2. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
 3. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations **scheduled on Drawings**.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.
2. PRODUCTS (Not Used)
3. EXECUTION (Not Used)

END OF SECTION

	011000 SUMMARY	
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SECTION 012500**SUBSTITUTION PROCEDURES****1. GENERAL****1. RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

2. SUMMARY

1. Section includes administrative and procedural requirements for substitutions.

3. 1. Division 01 Section "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers. **DEFINITIONS**

1. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

4. ACTION SUBMITTALS

1. Substitution Requests: Submit copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use form provided in Project Manual.

1. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
2. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
3. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
4. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
5. Samples, where applicable or requested.
6. Certificates and qualification data, where applicable or requested.
7. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
8. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
9. Research reports evidencing compliance with building code in effect for Project, from [ICC-ES].
10. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
11. Cost information, including a proposal of change, if any, in the Contract Sum.
12. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in

	012500 SUBSTITUTION PROCEDURES	
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substitution request, is compatible with related materials, and is appropriate for applications indicated.

13. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 work days of receipt of a request for substitution. Architect will notify Contractor **through Construction Manager** of acceptance or rejection of proposed substitution within 15 work days of receipt of request, or 7 work days of receipt of additional information or documentation, whichever is later.
 1. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 2. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.
5. QUALITY ASSURANCE
 1. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.
6. PROCEDURES
 1. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.
2. PRODUCTS
 1. SUBSTITUTIONS
 1. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 work days prior to time required for preparation and review of related submittals.
 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 1. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 2. Requested substitution provides sustainable design characteristics that specified product provided
 3. Substitution request is fully documented and properly submitted.
 4. Requested substitution will not adversely affect Contractor's construction schedule.
 5. Requested substitution has received necessary approvals of authorities having jurisdiction.
 6. Requested substitution is compatible with other portions of the Work.
 7. Requested substitution has been coordinated with other portions of the Work.
 8. Requested substitution provides specified warranty.
 9. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
 2. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after Commencement of work. Requests received after that time may be considered or rejected at discretion of Architect.
 1. 1.Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements: Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

	012500 SUBSTITUTION PROCEDURES	
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2. Requested substitution does not require extensive revisions to the Contract Documents.
3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Requested substitution provides sustainable design characteristics that specified product provided [for achieving LEED prerequisites and credits].
5. Substitution request is fully documented and properly submitted.
6. Requested substitution will not adversely affect Contractor's construction schedule.
7. Requested substitution has received necessary approvals of authorities having jurisdiction.
8. Requested substitution is compatible with other portions of the Work.
9. Requested substitution has been coordinated with other portions of the Work.
10. Requested substitution provides specified warranty.
11. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

EXECUTION (Not Used)

END OF SECTION

	012500 SUBSTITUTION PROCEDURES	
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SECTION 012501**SUBSTITUTION REQUEST FORM**

PROJECT: _____ (After Contract Award)

TO: _____

DATE: _____

Contractor hereby requests acceptance of the following product or system as a substitution in accordance with provisions of Division 01 Section "Substitution Procedures:"

1. SPECIFIED PRODUCT OR SYSTEM

Substitution request for: _____
Specification Section No.: _____ Article/ Paragraph: _____

2. REASON FOR SUBSTITUTION REQUEST**SPECIFIED PRODUCT . . .**

- ☐ Is no longer available.
- ☐ Is unable to meet project schedule.
- ☐ Is unsuitable for the designated application.
- ☐ Cannot interface with adjacent materials.
- ☐ Is not compatible with adjacent materials.

convenience

- ☐ Cannot provide the specified warranty.
- ☐ Other: _____
- ☐ Cannot be constructed as indicated
- ☐ Cannot be obtained due to one or more of the following:
- ☐ Strike
- ☐ Bankruptcy of manufacturer or supplier
- ☐ Lockout
- ☐ Similar occurrence (explain below)

PROPOSED PRODUCT . . .

- ☐ Will reduce construction time
- ☐ Will result in cost savings of
\$ _____ to Project
- ☐ Is for supplier's convenience
- ☐ Is for subcontractor's

3. SUPPORTING DATA

- ☐ Drawings, specifications, product data, performance data, test data, and any other necessary information to facilitate review of the Substitution Request is attached.
- ☐ Sample is attached. ☐ Sample will be sent if requested.

1.4

QUALITY COMPARISON

	012501 SUBSTITUTION REQUEST FORM	
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ROOT Architecture LLC. – Austin,
TX**City of Waco Convention Center HVAC Replacement-
Phase II**Waco, Texas
ROOT Project No.22128Provide all necessary side-by-side comparative data as required to facilitate review of Substitution
Request:

	SPECIFIED PRODUCT	PROPOSED PRODUCT
Manufacturer:	_____	_____
Name / Brand:	_____	_____
Catalog No.:	_____	_____
Vendor:	_____	_____
Variations:	_____	_____

(Attach additional sheets if necessary)

Local Distributor or Supplier: _____

Maintenance Service Available: ☐ Yes ☐ No

Spare Parts Source: _____

Warranty: ☐ Yes ☐ No _____ Years

1.5 PREVIOUS INSTALLATIONS

Identification of at least three similar projects on which proposed substitution was used:

PROJECT #1:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #2:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #3:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

1.6 EFFECT OF SUBSTITUTION

Proposed substitution affects other work or trades: ☐ No ☐ Yes (If yes, explain.)

012501 SUBSTITUTION
REQUEST FORM

ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement- Phase II Waco, Texas ROOT Project No.22128
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Proposed substitution requires dimensional revisions or redesign of architectural, structural, M E P, life safety, or other work:

☐ No ☐ Yes (if yes, attach data explaining revisions)

1.7 STATEMENT OF CONFORMANCE OF REQUEST TO CONTRACT REQUIREMENTS

Contractor and Subcontractor have investigated the proposed substitution and hereby represent that:

- A. They have personally investigated the proposed substitution and believe that it is equal to or superior in all respects to specified product, except as stated above.
- B. The proposed substitution is in compliance with applicable codes and ordinances.
- C. The proposed substitution will provide same warranty as specified for specified product.
- D. They will coordinate the incorporation of the proposed substitution into the Work, and will include modifications to the Work as required to fully integrate the substitution.
- E. They have included complete cost data and implications of the substitution (attached).
- F. They will pay any redesign fees incurred by the Architect or any of the Architect's consultants, and any special inspection costs incurred by the Owner, caused by the use of this product.
- G. They waive all future claims for added cost or time to the Contract related to the substitution, or that become known after substitution is accepted.
- H. The Architect's approval, if granted, will be based upon reliance upon data submitted and the opinion, knowledge, information, and belief of the Architect at the time decision is rendered and Addendum is issued; and that Architect's approval therefore is interim in nature and subject to reevaluation and reconsideration as additional data, materials, workmanship, and coordination with other work are observed and reviewed.

Contractor: _____
(Name of Contractor)

Date: _____ By: _____

Subcontractor: _____
(Name of Subcontractor)

Date: _____ By: _____

Note: Unresponsive or incomplete requests will be rejected and returned without review.

1.8 ARCHITECT'S REVIEW AND ACTION

- ☐ Substitution is accepted.
- ☐ Substitution is accepted, with the following comments: _____

☐ Resubmit Substitution Request:

☐ Provide more information in the following areas: _____

	012501 SUBSTITUTION REQUEST FORM	
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ROOT Architecture LLC. – Austin,
TX**City of Waco Convention Center HVAC Replacement-
Phase II**Waco, Texas
ROOT Project No.22128

- ☐ Provide proposal indicating amount of savings / credit to Owner
- ☐ Bidding Contractor shall sign Bidder's Statement of Conformance
- ☐ Bidding Subcontractor shall sign Bidder's Statement of Conformance

☐ Substitution is not accepted:

- ☐ Substitution Request received too late.
- ☐ Substitution Request received directly from subcontractor or supplier.
- ☐ Substitution Request not submitted in accordance with requirements.
- ☐ Substitution Request Form is not properly executed.
- ☐ Substitution Request does not indicate what item is being proposed.
- ☐ Insufficient information submitted to facilitate proper evaluation.
- ☐ Proposed product does not appear to comply with specified requirements.
- ☐ Proposed product will require substantial revisions to Contract Documents.

By: _____

Date: _____

Architect has relied upon the information provided by the Contractor, and makes no claim as to the accuracy, completeness, or validity of such information. If an accepted substitution is later found to be not in compliance with the Contract Documents, Contractor shall provide the specified product.

1.9 OWNER'S REVIEW AND ACTION

- ☐ Substitution is accepted; Architect to prepare Change Order.
- ☐ Substitution is not accepted.
- ☐ Owner will pay Architect directly for redesign fees.
- ☐ Include Architect's Additional Service fee for implementing the substitution in the Change Order.

By: _____

Date: _____
(Owner/Owner's Representative)

END OF FORM012501 SUBSTITUTION
REQUEST FORM

ROOT Architecture LLC. – Austin, TX		City of Waco Convention Center HVAC Replacement-Phase II Waco, Texas ROOT Project No.22128
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SECTION 012600**CONTRACT MODIFICATION PROCEDURES**

1. GENERAL
1. RELATED DOCUMENTS
 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
2. SUMMARY
 1. Section includes administrative and procedural requirements for handling and processing Contract modifications.
 1. Division 01 Section "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.
3. MINOR CHANGES IN THE WORK
 1. Architect will issue through Construction Manager supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.
4. PROPOSAL REQUESTS
 1. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 1. Work Change Proposal Requests issued by Construction Manager are not instructions either to stop work in progress or to execute the proposed change.

Within **15 work** days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

- a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
- b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
- c. Include costs of labor and supervision directly attributable to the change.
- d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- e. Quotation Form: Use **CSI Form 13.6D, "Proposal Worksheet Summary," and Form 13.6C, "Proposal Worksheet Detail," forms provided by Owner. Sample copies are included in Project Manual.**
 - B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Construction Manager.
 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 4. Include costs of labor and supervision directly attributable to the change.
 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 6. Comply with requirements in Division 01 Section "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.

END OF SECTION

	012600 CONTRACT MODIFICATION PROCEDURES	
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SECTION 013100**PROJECT MANAGEMENT AND COORDINATION****1. GENERAL****1. RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

2. SUMMARY

1. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 1. General coordination procedures.
 2. Coordination drawings.
 3. Requests for Information (RFIs).
 4. Project meetings.
2. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
3. Related Requirements:

3. DEFINITIONS

1. RFI: Request from Owner, Construction Manager, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

4. INFORMATIONAL SUBMITTALS

1. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use CSI Form 1.5A. Include the following information in tabular form:
 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 2. Number and title of related Specification Section(s) covered by subcontract.
 3. Drawing number and detail references, as appropriate, covered by subcontract.
 2. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
1. Post copies of list in project meeting room, in temporary field office and by each temporary telephone. Keep a list current at all times.

5. GENERAL COORDINATION PROCEDURES

1. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different sections, that depend on each other for proper installation, connection, and operation.
 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
 2. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different sections, that depend on each other for proper installation, connection, and operation.
1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

	013100 PROJECT MANAGEMENT AND COORDINATION	
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2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.
 3. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
 4. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Pre-installation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.
 5. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

END OF SECTION

	013100 PROJECT MANAGEMENT AND COORDINATION	
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SECTION 013200**CONSTRUCTION PROGRESS DOCUMENTATION****1. GENERAL****1. RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

2. SUMMARY

1. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's construction schedule.
3. Daily construction reports.
4. Material location reports.
5. Special reports.

3. DEFINITIONS.

1. 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.
1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.
 2. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
 3. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
 4. Event: The starting or ending point of an activity.
 5. Float: The measure of leeway in starting and completing an activity.
1. Float time belongs to Owner and is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date].
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
 6. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

4. INFORMATIONAL SUBMITTALS

1. Format for Submittals: Submit required submittals in the following format:
 1. Working electronic copy of schedule file, where indicated.
 2. PDF electronic file.
 2. Startup construction schedule.
 3. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
 4. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
1. Submit a working electronic copy of schedule, labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
 5. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity

	013200 CONSTRUCTION PROGRESS AND DOCUMENTATION	
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description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from [commencement of the Work] [the Notice to Proceed] until most recent Application for Payment.
 6. Construction Schedule Updating Reports: Submit with Applications for Payment.
 7. Daily Construction Reports: Submit at monthly intervals.
 8. Material Location Reports: Submit at monthly intervals.
 9. Site Condition Reports: Submit at time of discovery of differing conditions.
 10. Special Reports: Submit at time of unusual event.
 11. Qualification Data: For scheduling consultant.
5. QUALITY ASSURANCE
 1. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.
 2. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
 1. Review software limitations and content and format for reports.
 2. Verify availability of qualified personnel needed to develop and update schedule.
 3. Discuss constraints, including phasing, work stages, interim milestones.
 4. Review schedule for work of Owner's separate contracts.
 5. Review submittal requirements and procedures.
 6. Review time required for review of submittals and resubmittals.
 7. Review requirements for tests and inspections by independent testing and inspecting agencies.
 8. Review time required for Project closeout and Owner startup procedures.
 9. Review and finalize list of construction activities to be included in schedule.
 10. Review procedures for updating schedule.
6. COORDINATION
 1. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
 2. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 1. Secure time commitments for performing critical elements of the Work from entities involved.
 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.
2. PRODUCTS
 1. CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL
 1. Time Frame: Extend schedule from date established for commencement of the Work the Notice of Award, the Notice to Proceed to date of Substantial Completion, and final completion.
 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
 2. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
 1. Activity Duration: Define activities so no activity is longer than 20 work days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement

	013200 CONSTRUCTION PROGRESS AND DOCUMENTATION	
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cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
6. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.
 3. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
2. Work under More Than One Contract: Include a separate activity for each contract.
3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
6. Work Restrictions: Show the effect of the following items on the schedule:
 1. Limitations of continued occupancies.
 2. Uninterruptible services.
 3. Partial occupancy before Substantial Completion.
 4. Use of premises restrictions.
 5. Provisions for future construction.
 6. Seasonal variations.
 7. Environmental control.
7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 1. Subcontract awards.
 2. Submittals.
 3. Purchases.
 4. Fabrication.
 5. Deliveries.
 6. Installation.
 7. Tests and inspections.
 8. Adjusting.
 9. Startup and placement into final use and operation.
8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 1. Structural completion.
 2. Temporary enclosure and space conditioning.
 3. Permanent space enclosure.
 4. Completion of mechanical installation.
 5. Completion of electrical installation.
 6. Substantial Completion.
9. Other Constraints:
 4. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
1. Temporary enclosure and space conditioning.

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- E. **Cost Correlation:** Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
- F. **Upcoming Work Summary:** Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and Contract Time.
- G. **Recovery Schedule:** When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
- H. **Computer Scheduling Software:** Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
2. **CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)**
- A. **Gantt-Chart Schedule:** Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 30 days of date established for commencement of the Work. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. **Preparation:** Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.
3. **REPORTS**
- A. **Daily Construction Reports:** Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (see special reports).
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. Substantial Completions authorized.
- B. **Material Location Reports:** At weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.

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3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
4. SPECIAL REPORTS
- A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
3. EXECUTION
1. CONTRACTOR'S CONSTRUCTION SCHEDULE
1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
 2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Architect, Construction Manager, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

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SECTION 013300**SUBMITTAL PROCEDURES****1. GENERAL****1. RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

2. SUMMARY

1. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
2. Related Requirements:
 1. Division 01 Section "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 2. Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 3. Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 4. Division 01 Section "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 5. Division 01 Section "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

3. DEFINITIONS

Action Submittals: Written and graphic information and physical samples that require Architect's and Construction Manager's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

A. Informational Submittals: Written and graphic information and physical samples that do not require Architect's and Construction Manager's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

B. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

C. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

4. ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and construction manager and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 1. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
4. Format: Arrange the following information in a tabular format:
 1. Scheduled date for first submittal.
 2. Specification Section number and title.

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3. Submittal category: Action; informational.
4. Name of subcontractor.
5. Description of the Work covered.
6. Scheduled date for Architect's final release or approval.
7. Scheduled date of fabrication.

5. **SUBMITTAL ADMINISTRATIVE REQUIREMENTS**

A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals.

1. Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and Project record drawings.
 1. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 2. Digital Drawing Software Program: The Contract Drawings are available in dwg. Form with AutoCAD on Windows OS.
 3. Contractor shall execute a data licensing agreement in the form of AIA Document C106, Digital Data Licensing Agreement.
 4. The following digital data files will be furnished for each appropriate discipline:
 1. Floor plans.
 2. Reflected ceiling plans.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 1. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 work days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 work days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.

a. Submittal number or other unique identifier, including revision identifier.

1. Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

b. Number and title of appropriate Specification Section.

c. Drawing number and detail references, as appropriate.

d. Location(s) where product is to be installed, as appropriate.

e. Other necessary identification.

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D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
 1. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
4. Transmittal Form for Electronic Submittals: Use PDF from Adobe acceptable to Owner, containing the following information:
 1. Project name.
 2. Date.
 3. Name and address of Architect.
 4. Name of Construction Manager.
 5. Name of Contractor.
 6. Name of firm or entity that prepared submittal.
 7. Names of subcontractor, manufacturer, and supplier.
 8. Category and type of submittal.
 9. Submittal purpose and description.
 10. Specification Section number and title.
 11. Specification paragraph number or drawing designation and generic name for each of multiple items.
 12. Drawing number and detail references, as appropriate.
 13. Location(s) where product is to be installed, as appropriate.
 14. Related physical samples submitted directly.
 15. Indication of full or partial submittal.
 16. Submittal and transmittal distribution record.
 17. Other necessary identification.
 18. Remarks (optional).

E. Options: Identify options requiring selection by Architect.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

2. PRODUCTS

1. SUBMITTAL PROCEDURES

1. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 1. Submit electronic submittals via email as PDF electronic files.
 1. Architect, through Construction Manager, will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 2. Action Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect, through Construction Manager, will return two copies.
 3. Informational Submittals: Submit two paper copies of each submittal unless otherwise indicated. Architect and Construction Manager will not return copies.

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4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
- a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 1. Manufacturer's catalog cuts.
 2. Manufacturer's product specifications.
 3. Standard color charts.
 4. Statement of compliance with specified referenced standards.
 5. Testing by recognized testing agency.
 6. Application of testing agency labels and seals.
 7. Notation of coordination requirements.
 8. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 1. Wiring diagrams showing factory-installed wiring.
 2. Printed performance curves.
 3. Operational range diagrams.
 4. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before or concurrent with Samples.
 6. Submit Product Data in the following format:
 1. PDF electronic file.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Architect's digital data drawing files is otherwise permitted.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 1. Identification of products.
 2. Schedules.
 3. Compliance with specified standards.
 4. Notation of coordination requirements.
 5. Notation of dimensions established by field measurement.
 6. Relationship and attachment to adjoining construction clearly indicated.
 7. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least **8-1/2 by 11 inches (215 by 280 mm)**, but no larger than **30 by 42 inches (750 by 1067 mm)**.
 3. Submit Shop Drawings in the following format:
 1. PDF electronic file.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
 5. Submit product schedule in the following format:
 1. PDF electronic file.

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- E. Coordination Drawing Submittals: Comply with requirements specified in Division 01 Section "Project Management and Coordination."
- F. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- G. Application for Payment and Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."
- H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Division 01 Section "Quality Requirements."
- I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 01 Section "Closeout Procedures."
- J. Maintenance Data: Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."
- K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- L. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- Q. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- R. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
1. Name of evaluation organization.
 2. Date of evaluation.
 3. Time period when report is in effect.
 4. Product and manufacturers' names.
 5. Description of product.
 6. Test procedures and results.
 7. Limitations of use.
- T. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- U. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- V. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- W. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
2. DELEGATED-DESIGN SERVICES

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A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

3. 1.If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to the Architect. EXECUTION

1. CONTRACTOR'S REVIEW

1. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect and Construction Manager.
2. Project Closeout and Maintenance Material Submittals: See requirements in Division 01 Section "Closeout Procedures."
3. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

2. ARCHITECT'S AND CONSTRUCTION MANAGER'S ACTION

1. Action Submittals: Architect and Construction Manager will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect and Construction Manager will stamp each submittal with an action stamp and will mark stamp appropriately to indicate

1. Final Unrestricted Release: Where the submittals are marked as follows, the work covered by the submittal may proceed provided it complies with the requirements of the Contract Documents; acceptance of the work will depend on that compliance.

- a. Marking: "No Exceptions Taken".

2. Rejection: When the submittal is marked as follows, do not proceed with the work covered by the submittal, including purchasing, fabrication, delivery, or other activity. The work covered by the submittal does not conform to design concept or meet Contract Document requirements. Do not permit submittals with this marking to be used on project site or elsewhere where project work is in progress.

- a. Marking: "Rejected" or "Submit Specified Item"

3. Final-But-Restricted Release: When submittals are marked as follows, that part of the work covered by the submittal may proceed provided it complies with both the Architect's notations or corrections on the Submittal and the requirements of the Contract Documents; final acceptance will depend on that compliance.

- a. Marking: "Make Corrections Noted".

4. Returned for Resubmittal: When submittal is marked as follows, do not proceed with the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the Architect's notations stating the reasons for returning the submittal; resubmit without delay. Repeat if necessary to obtain a different action mark. Do not permit submittals with the following mark to be used at the project site or elsewhere where work is in progress.

- a. Marking: "Revise and Resubmit".

5. Reviews by Consultants: Where submittals are marked by the Architect as indicated below, they have been reviewed by the Architect's consultant having primary responsibility for the work shown and bear the respective consultant's action markings. The Architect's marking indicates Architect's additional review that is only for areas of concern regarding aesthetic intent.

- a. Marking: "See Consultant's Action Stamp".

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6. Other Action: Where the submittal is primarily for information or record purposes, the submittal will be marked as follows:

- B.
 - a. Marking: "Not reviewed". Informational Submittals: Architect and Construction Manager will review each submittal and will not return it or will return it if it does not comply with requirements. Architect and Construction Manager will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect and Construction Manager.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION

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ROOT Architecture LLC. – Austin,
TX**City of Waco Convention Center HVAC Replacement-
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ROOT Project No.22128**SECTION 014000****QUALITY REQUIREMENTS****1. GENERAL****1. RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

2. SUMMARY

1. Section includes administrative and procedural requirements for quality assurance and quality control.
2. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Commissioning Authority, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.

3. DEFINITIONS

1. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
2. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
3. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
1. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
 4. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
 5. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
 6. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
 7. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
 8. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
 9. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

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REQUIREMENTS

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1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum 5 previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
4. **CONFLICTING REQUIREMENTS**
 - A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.
 - B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.
5. **ACTION SUBMITTALS**
 - A. Shop Drawings: For integrated exterior mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
 1. Indicate manufacturer and model number of individual components.
 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.
6. **INFORMATIONAL SUBMITTALS**
 - A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
 - B. Qualification Data : For Contractor's quality-control personnel.
 - A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
 1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect.
 2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect.
 - B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
 - C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 1. Specification Section number and title.
 2. Entity responsible for performing tests and inspections.
 3. Description of test and inspection.
 4. Identification of applicable standards.
 5. Identification of test and inspection methods.
 6. Number of tests and inspections required.
 7. Time schedule or time span for tests and inspections.
 8. Requirements for obtaining samples.
 9. Unique characteristics of each quality-control service.
7. **REPORTS AND DOCUMENTS**
 - A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following when applicable:
 1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.

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9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. **Manufacturer's Technical Representative's Field Reports:** Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. **Factory-Authorized Service Representative's Reports:** Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. **Permits, Licenses, and Certificates:** For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.
8. **QUALITY ASSURANCE**
- A. **General:** Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. **Manufacturer Qualifications:** A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. **Fabricator Qualifications:** A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. **Installer Qualifications:** A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. **Testing Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E329 and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- G. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

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H. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. **Mockups:** Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect
2. Notify Architect 7 days in advance of dates and times when mockups will be constructed.
3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 1. Allow 7 days for initial review and each re-review of each mockup.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed unless otherwise indicated.

J. **Integrated Exterior Mockups:** Construct integrated exterior mockup [according to approved Shop Drawings] [as indicated on Drawings]. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.

9. QUALITY CONTROL

A. **Owner Responsibilities:** Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
3. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. **Contractor Responsibilities:** Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 1. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
3. Notify testing agencies at 24 hours in advance of time when Work that requires testing or inspecting will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."

D. **Manufacturer's Technical Services:** Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. **Retesting/Re-inspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

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F. **Testing Agency Responsibilities:** Cooperate with Architect, Commissioning Authority, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect, Commissioning Authority, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

G. **Associated Services:** Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. **Coordination:** Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. **Schedule of Tests and Inspections:** Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents[as a component of Contractor's quality-control plan]. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

10. SPECIAL TESTS AND INSPECTIONS

A. **Special Tests and Inspections:** Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections.

B. **PRODUCTS (Not Used)**

2. EXECUTION

1. TEST AND INSPECTION LOG

1. **Test and Inspection Log:** Prepare a record of tests and inspections. Include the following:
 1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
 5. Any supplementary information required by the target authorities having jurisdiction.
2. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

2. REPAIR AND PROTECTION

1. **General:** On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
2. Protect construction exposed by or for quality-control service activities.
3. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

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SECTION 016000**PRODUCT REQUIREMENTS****1. GENERAL****1. RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

2. SUMMARY

1. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
2. Related Requirements:

1. Division 01 Section "Substitution Procedures" for requests for substitutions.
2. Division 01 Section "References" for applicable industry standards for products specified.

3. DEFINITIONS

A. **Products:** Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. **Named Products:** Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
2. **New Products:** Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. **Comparable Product:** Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. **Basis-of-Design Product Specification:** A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

4. ACTION SUBMITTALS

A. **Comparable Product Requests:** Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. **Architect's Action:** If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor through Construction Manager of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
 1. **Form of Approval:** As specified in Division 01 Section "Submittal Procedures."
 2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

B. **Basis-of-Design Product Specification Submittal:** Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

5. QUALITY ASSURANCE

A. **Compatibility of Options:** If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.

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2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.
6. **PRODUCT DELIVERY, STORAGE, AND HANDLING**
 - A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
 - B. Delivery and Handling:
 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
 - C. Storage:
 1. Store products to allow for inspection and measurement of quantity or counting of units.
 2. Store materials in a manner that will not endanger Project structure.
 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 6. Protect stored products from damage and liquids from freezing.
 7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.
7. **PRODUCT WARRANTIES**
 - A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
 - B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 3. See Divisions 02 through 33 Sections for specific content requirements and particular requirements for submitting special warranties.
 - C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."
2. **PRODUCTS**

.Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

a. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.

4. **Manufacturers:**

a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

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b. Non-restricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.

5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

C. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2. COMPARABLE PRODUCTS

A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

3. EXECUTION (Not Used)

END OF SECTION

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SECTION 017300**EXECUTION****1. GENERAL****1. RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

2. SUMMARY

1. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Owner-installed products.
6. Progress cleaning.
7. Starting and adjusting.
8. Protection of installed construction.
9. Correction of the Work.

2. Related Requirements:

1. Division 01 Section "Summary" for limits on use of Project site.
2. Division 01 Section "Submittal Procedures" for submitting surveys.
3. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
4. Division 07 Section "Penetration Firestopping" for patching penetrations in fire-rated construction.

3. DEFINITIONS

1. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
2. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

- iii. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

1. Water, moisture, or vapor barriers.
2. Membranes and flashings.
3. Exterior curtain-wall construction.
4. Sprayed fire-resistive material.
5. Equipment supports.
6. Piping, ductwork, vessels, and equipment.
7. Noise- and vibration-control elements and systems.

C. EXECUTION**1. EXAMINATION**

1. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 1. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
2. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

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1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 3. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 1. Description of the Work.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections.
 4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.
2. PREPARATION
1. Existing Utility Information: Furnish information to owner and utility services that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
 2. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 3. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
 4. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Division 01 Section "Project Management and Coordination."
3. CONSTRUCTION LAYOUT
1. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect and Construction Manager promptly.
 2. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 2. Establish limits on use of Project site.
 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 4. Inform installers of lines and levels to which they must comply.
 5. Check the location, level and plumb, of every major element as the Work progresses.
 6. Notify Architect and Construction Manager when deviations from required lines and levels exceed allowable tolerances.
 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
 3. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
 4. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect and Construction Manager.
4. FIELD ENGINEERING
- a. Identification: Owner will identify existing benchmarks, control points, and property corners.

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- b. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - i. Do not change or relocate existing benchmarks or control points without prior written approval of Architect or Construction Manager. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect and Construction Manager before proceeding.
 - ii. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- c. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - i. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - ii. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - iii. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- d. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- e. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
 - i. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
 - ii. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."
- 5. INSTALLATION
 - a. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - i. Make vertical work plumb and make horizontal work level.
 - ii. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - iii. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 - iv. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.
 - b. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
 - c. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
 - d. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
 - e. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
 - f. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
 - g. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
 - h. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - i. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - ii. Allow for building movement, including thermal expansion and contraction.
 - iii. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
 - j. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
 - k. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

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6. CUTTING AND PATCHING

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- a. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
- i. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- b. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- c. Temporary Support: Provide temporary support of work to be cut.
- d. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- e. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Division 01 Section "Summary."
- f. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- g. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
- i. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
- ii. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
- iii. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
- iv. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
- v. Proceed with patching after construction operations requiring cutting are complete.
- h. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
- i. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
- ii. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 1. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 2. Restore damaged pipe covering to its original condition.
 3. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
- iii. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- i. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.
7. OWNER-INSTALLED PRODUCTS
- a. Site Access: Provide access to Project site for Owner's construction personnel.
- b. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
- i. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
- ii. Pre-installation Conferences: Include Owner's construction personnel at pre-installation conferences covering portions of the Work that are to receive Owner's work. Attend pre-installation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.
8. PROGRESS CLEANING
- a. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
- i. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.

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- ii. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).

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- iii. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - 1. Use containers intended for holding waste materials of type to be stored.
- iv. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
 - b. Site: Maintain Project site free of waste materials and debris.
 - c. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - i. Remove liquid spills promptly.
 - ii. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
 - d. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
 - e. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
 - f. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
 - g. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01 Section "Temporary Facilities and Controls." or Division 01 Section "Construction Waste Management and Disposal."
 - h. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
 - i. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
 - j. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.
- 9. **STARTING AND ADJUSTING**
 - a. Coordinate startup and adjusting of equipment and operating components with requirements in Division 01 Section "General Commissioning Requirements."
 - b. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
 - c. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
 - d. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - e. Manufacturer's Field Service: Comply with qualification requirements in Division 01 Section "Quality Requirements."
- 10. **PROTECTION OF INSTALLED CONSTRUCTION**
 - a. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
 - b. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION

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SECTION 017419**CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL****1. GENERAL****1. RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

2. SUMMARY

1. Section includes administrative and procedural requirements for the following:
 1. Salvaging nonhazardous construction waste.
 2. Recycling nonhazardous construction waste.
 3. Disposing of nonhazardous construction waste.
2. Related Requirements:
 1. Division 02 Section "Selective Structure Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements, and for disposition of hazardous waste.

3. DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

4. PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 50 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials including the following if possible:

1. Demolition Waste:
 1. Asphalt paving.
 2. Concrete.
 3. Concrete reinforcing steel.
 4. Brick.
 5. Concrete masonry units.
 6. Wood studs.
 7. Wood joists.
 8. Plywood and oriented strand board.
 9. Wood paneling.
 10. Wood trim.
 11. Structural and miscellaneous steel.
 12. Rough hardware.
 13. Roofing.
 14. Insulation.
 15. Doors and frames.
 16. Door hardware.
 17. Windows.
 18. Glazing.

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19. Metal studs.
20. Gypsum board.
21. Acoustical tile and panels.
22. Carpet.
23. Carpet pad.
24. Demountable partitions.
25. Equipment.
26. Cabinets.
27. Plumbing fixtures.
28. Piping.
29. Supports and hangers.
30. Valves.
31. Sprinklers.
32. Mechanical equipment.
33. Refrigerants.
34. Electrical conduit.
35. Copper wiring.
36. Lighting fixtures.
37. Lamps.
38. Ballasts.
39. Electrical devices.
40. Switchgear and panelboards.
41. Transformers.

2. Construction Waste:

1. Masonry and CMU.
2. Lumber.
3. Wood sheet materials.
4. Wood trim.
5. Metals.
6. Roofing.
7. Insulation.
8. Carpet and pad.
9. Gypsum board.
10. Piping.
11. Electrical conduit.
12. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

1. Paper.
2. Cardboard.
3. Boxes.
4. Plastic sheet and film.
5. Polystyrene packaging.
6. Wood crates.
7. Plastic pails.

5. ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 7 days of date established for the Notice to Proceed.

6. INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Form CWM-7 for construction waste and Form CWM-8 for demolition waste Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in **tons** (tonnes).
4. Quantity of waste salvaged, both estimated and actual in **tons** (tonnes).

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5. Quantity of waste recycled, both estimated and actual in **tons** (tonnes).

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6. Total quantity of waste recovered (salvaged plus recycled) in **tons (tonnes)**.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- D. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- E. Qualification Data: For waste management coordinator
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
7. QUALITY ASSURANCE
 - A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
 - B. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
 - C. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
 1. Review and discuss waste management plan including responsibilities of waste management coordinator.
 2. Review requirements for documenting quantities of each type of waste and its disposition.
 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 5. Review waste management requirements for each trade.
8. WASTE MANAGEMENT PLAN
 - A. Waste Identification: Indicate anticipated types and quantities of site-clearing and construction waste generated by the Work. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. Include estimated quantities and assumptions for estimates.
 - B. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use Form CWM-3 for construction waste and Form CWM-4 for demolition waste. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
2. PRODUCTS (Not Used)
3. EXECUTION
 1. PLAN IMPLEMENTATION
 1. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 1. Comply with operation, termination, and removal requirements in Division 01 Section "Temporary Facilities and Controls."
 2. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
 3. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 1. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
 4. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
 2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.
 2. RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

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1. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be shared equally by Owner and Contractor.
2. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
3. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 1. Inspect containers and bins for contamination and remove contaminated materials if found.
2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.
3. RECYCLING CONSTRUCTION WASTE
 1. Packaging:
 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 2. Polystyrene Packaging: Separate and bag materials.
 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
 2. Wood Materials:
 1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
4. DISPOSAL OF WASTE
 1. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 2. Burning: Do not burn waste materials.
 3. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION

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SECTION 017839**PROJECT RECORD DOCUMENTS****1. GENERAL****1. RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

2. SUMMARY

1. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

2. Related Requirements:

1. Division 01 Section "Execution" for final property survey.
2. Division 01 Section "Closeout Procedures" for general closeout procedures.
3. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.

3. CLOSEOUT SUBMITTALS**A. Record Drawings: Comply with the following:**

1. Number of Copies: Submit one set of marked-up record prints.
2. Number of Copies: Submit copies of record Drawings as follows:
 1. Initial Submittal:
 1. Submit PDF electronic files of scanned record prints and one of file prints.
 2. Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

B. Record Specifications: Submit one annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.**C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.**

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.**E. Reports: Submit written report weekly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.****2. PRODUCTS****1. RECORD DRAWINGS**

1. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

1. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
2. Accurately record information in an acceptable drawing technique.
3. Record data as soon as possible after obtaining it.
4. Record and check the markup before enclosing concealed installations.
5. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

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1. Dimensional changes to Drawings.
 2. Revisions to details shown on Drawings.
 3. Depths of foundations below first floor.
 4. Locations and depths of underground utilities.
 5. Revisions to routing of piping and conduits.
 6. Revisions to electrical circuitry.
 7. Actual equipment locations.
 8. Duct size and routing.
 9. Locations of concealed internal utilities.
 10. Changes made by Change Order or Construction Change Directive.
 11. Changes made following Architect's written orders.
 12. Details not on the original Contract Drawings.
 13. Field records for variable and concealed conditions.
 14. Record information on the Work that is shown only schematically.
3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
 2. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect and Construction Manager. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
 1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
 2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
 1. See Division 01 Section "Submittal Procedures" for requirements related to use of Architect's digital data files.
 2. Architect will provide data file layer information. Record markups in separate layers.
 3. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
 1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 1. Project name.
 2. Date.
 3. Designation "PROJECT RECORD DRAWINGS."
 4. Name of Architect
 5. Name of Contractor.
2. RECORD SPECIFICATIONS
 1. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

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2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
5. Note related Change Orders, record Product Data, and record Drawings where applicable.
 2. Format: Submit record Specifications as annotated PDF electronic file
3. RECORD PRODUCT DATA
 1. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
 2. Format: Submit record Product Data as annotated PDF electronic file
 1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.
4. MISCELLANEOUS RECORD SUBMITTALS
 1. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
 2. Format: Submit miscellaneous record submittals as PDF electronic file
 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.
3. EXECUTION
1. RECORDING AND MAINTENANCE
 1. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
 2. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for reference during normal working hours.

END OF SECTION

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SECTION 071200**FLUID-APPLIED MEMBRANE AIR BARRIERS – VAPOR PERMEABLE****1. GENERAL****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.

2. SUMMARY

B. This Section includes the following:
Fluid-applied membrane air barrier, vapor permeable.

3. DEFINITIONS

C. ABAA: Air Barrier Association of America.

D. Air Barrier Assembly: The collection of air barrier materials and auxiliary materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

4. PERFORMANCE REQUIREMENTS

E. General: Air barrier shall be capable of performing as a continuous vapor-permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

F. Material Compatibility: Provide materials that are compatible with one another under conditions of service and application required, as demonstrated by manufacturer based on testing and field experience.

G. The building envelope shall be designed and constructed with a continuous air barrier to control air leakage into or out of the conditioned space. An air barrier shall also be provided for interior partitions between conditioned space and space designed to maintain temperature or humidity levels which differ from those in the conditioned space by more than 50% of the difference between the conditioned space and design ambient conditions. The air barrier shall have the following characteristics:

1. It must be continuous, with all joints made airtight.
2. It shall have an air permeability not to exceed 0.004 cfm/sq. ft. under a pressure differential of 0.3 in. water. (1.57 psf.) (equal to 0.02L/sq. m @ 75 Pa.)
3. It shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on the envelope without damage or displacement, and shall transfer the load to the structure. It shall not displace adjacent materials under full load.
4. The air barrier shall be joined in an airtight and flexible manner to the air barrier material of adjacent systems, allowing for the relative movement of systems due to thermal and moisture variations and creep. Connection shall be made between:

- a. Foundation and walls.
- b. Walls and windows or doors.
- c. Different wall systems.
- d. Wall and roof.
- e. Wall and roof over unconditioned space.
- f. Walls, floor and roof across construction, control and expansion joints.
- g. Walls, floors and roof to utility, pipe and duct penetrations.
5. All penetrations of the air barrier and paths of air infiltration/exfiltration shall be made airtight.

5. SUBMITTALS

H. Source Limitations: Obtain each type of system from single source from single manufacturer.

I. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; installation instructions; and tested physical and performance properties of air barrier.

6. For fluid applied materials provide the minimum time that must pass before additional applications of fluid applied material may be installed.

7. For primers provide the maximum time that may pass before primer must be reapplied.

8. For systems that require different primers for different substrates, indicate if one primer must be installed before or after another type of primer on an adjacent substrate.

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9. For membrane materials provide the maximum time that may pass before solvent wiping or abrasion is required before application of additional coats of membrane materials.
10. For membrane at expansion joints, submit the manufacturer's written product and technical data, as well as, tested physical performance properties.
- J. Submit shop drawings Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction. These drawings shall be site specific. Manufacturer's standard details will not be accepted. Include details of interfaces with other materials that form part of air barrier.
- K. Product Certificates: For air barriers, certifying compatibility of air barrier and accessory materials with Project materials that connect to or, that come in contact with the barrier; signed by product manufacturer.
- L. Manufacturer Certificate: Signed by manufacturer, stating that the product manufacturer has reviewed and approved the shop drawings and certifying that air barrier system complies with specified requirements.
11. Written approval by manufacturer for use and performance of air barrier system over specified substrate, including, that materials supplied for project comply with requirements of cited ASTM standards and Project Documents.
- M. Installer Certificate
12. Signed by manufacturer, certifying that Installer complies with manufacturer's requirements to install specified, warranted system.
13. Submit evidence that Installer's existing company has minimum of 5 years continuous experience in application of specified materials. Submit list of at least five completed projects of similar scope and size.
- N. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for air barriers.
- O. Sample Warranty: Copy of manufacturer's warranty, stating obligations, remedies, limitations, and exclusions. Submitted with bid.
- P. Following completion of Work, submit manufacturer's inspection report of completed installation and completed warranty; submit Installer's completed warranty.
- Q. Maintenance data for air barrier system.
6. **QUALITY ASSURANCE**
- R. General: In general, materials to be obtained from one (1) manufacturer. The use of other materials must be acknowledged and approved by both the primary manufacturer and the supplier of incidental materials, each accepting the other.
14. Portions of these specifications may exceed the minimum requirements of material manufacturer(s). Installer to comply, first with these Specifications, and secondly, with the manufacturer's recommendations and instructions. In no event will less quality, less weight or any other lesser requirements be acceptable than at least the minimum of such required by this Section and those of the manufacturer(s).
- h. The current published product and installation literature of these materials manufacturers will be considered part of this specification. Any revisions to the published literature, prior to the date of installation of the project will also be considered part of this specification.
- i. Maintain one copy of contract documents and submittals on site at all times during work activities.
- S. Installer's Qualifications: Qualified firm that is approved, authorized, or licensed by manufacturer to install products and that is eligible to receive system warranty. Must have installations of specified materials in local area in use for minimum of 5 years.
15. Employ foreman with minimum of 5-years experience as foreman on similar projects to be on site at all times during Work.
- T. Manufacturer Qualifications: A qualified manufacturer with a minimum of ten (10) years documented experience that has UL listing and FMG approval for air barrier system identical to that used for this Project.
- U. Preinstallation Conference: Conduct conference at Project site.
16. Include installers of other construction connecting to air barrier, including roofing, waterproofing, architectural precast concrete, masonry, sealants, windows, glazed curtain walls, and door frames.
17. Review air barrier requirements including surface preparation, substrate condition and pretreatment, minimum substrate curing period, forecasted weather conditions, special details and sheet flashings, , installation procedures, sequence of installation, testing and inspecting procedures, and protection and repairs.
7. **DELIVERY, STORAGE, AND HANDLING**
- V. Deliver materials to Site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, and directions for storing. Protect from damage from sunlight, weather, excessive temperatures, and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.
- W. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms within temperature range required by manufacturer.

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- X. Store rolled materials on ends only, unless otherwise required by manufacturer's written instructions. Discard rolls that have been flattened, creased, or otherwise damaged.
- Y. Handle materials to avoid damage.
- Z. Conspicuously mark damaged materials and promptly remove from Site.
- AA. Do not double-stack pallets of fluid applied membrane components on the job site. Provide cover on top and all sides, allowing for adequate ventilation.
- BB. Protect fluid-applied membrane components from freezing and extreme heat.

8. PROJECT CONDITIONS

- CC. Verify existing dimensions and details prior to installation of materials. Notify Architect/Engineer of conditions found to be different than those indicated in Contract Documents.
- DD. Comply with Owner's limitations and restrictions for site use and accessibility.
- EE. Environmental Limitations: Install system when existing and forecast weather conditions permit system to be installed according to system manufacturer's written instructions and warranty requirements.
- FF. Do not proceed with installation during inclement weather except for temporary work necessary to protect building interior and installed materials. Remove temporary work and Work that becomes moisture damaged.
- GG. Install materials in strict accordance with safety requirements required by manufacturer, Material Safety Data Sheets, and local, state, and federal rules and regulations.
- HH. Apply air barrier within the range of ambient and substrate temperatures recommended by air barrier manufacturer. Protect substrates from environmental conditions that affect performance of air barrier. Do not apply air barrier to a wet substrate or during snow, rain, fog, or mist.

9. 1.10 WARRANTY

- A. See Section 017839 - Closeout Submittals, for additional warranty requirements
- B. Warranty: Add Manufacturer's standard form in which manufacturer agrees to replace fluid-applied air barrier membrane materials, that fail within specified warranty period when installed and used in strict conformance with written manufacturer's instructions.
- 18. Failures include, but are not limited to, the following:
 - j. Failure to maintain air permeance rating not to exceed .004 cfm/sq. ft (0.02 L/s/sq. m.) when tested per ASTM E2178, within specified warranty period.
 - k. Failure to maintain a vapor permeance rating greater than 10 perms when tested in accordance with ASTM E96, Method B.
- 19. Warranty Period: Five years from date of Substantial Completion.

2. PRODUCTS

10. FLUID-APPLIED MEMBRANE AIR BARRIER

- II. Fluid-Applied, Vapor-Permeable Membrane Air and Moisture Barrier: Elastomeric, modified bituminous membrane.
- JJ. Products: Subject to compliance with requirements, provide one of the following:
- 20. Single-Component Polymer-Modified Membrane:
 - I. W.R. Meadows, Inc.; Air-Shield LMP
- 21. Physical and Performance Properties:
 - m. Membrane Air Permeance: Not to exceed 0.004 cfm/ sq. ft. of surface area at 1.57-lbf/sq. ft.0.02 L/s x sq. m of surface area at 75-Pa pressure difference; ASTM E 2178.
 - n. Membrane Vapor Permeance: Not less than 10 perms580 ng/Pa x s x sq. m; ASTM E 96.
 - o. Assembly Performance: Provide a continuous air barrier assembly that has an air leakage not to exceed 0.008 cfm/sq. ft. of surface area under a pressure differential of 0.3 in. water (1.57 pounds per square foot) (0.004 L/s x sq. m of surface area at 75-Pa) when tested in accordance with ASTM E 2357.

11. AUXILIARY MATERIALS

- KK. General: Auxiliary materials recommended by air barrier manufacturer for intended use and compatible with air barrier membrane. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- LL. Wall Primer: Liquid waterborne primer recommended for substrate by manufacturer of air barrier material.
- MM. Counterflashing Strip: Modified bituminous, 40-mil- (1.0-mm-) thick, self-adhering sheet consisting of 32 mils (0.8 mm) of rubberized asphalt laminated to an 8-mil- (0.2-mm-) thick, cross-laminated polyethylene film with release liner backing.
- 22. Acceptable Product: W.R. Meadows, Inc.; Air Shield TWF.
- NN. Joint Reinforcing Strip: Air barrier manufacturer's glass-fiber-mesh tape.

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- OO. Substrate Patching Membrane: Manufacturer's standard trowel-grade substrate filler.
- PP. Adhesive and Tape: Air barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.
- QQ. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, 0.0187 inch/0.5 mm thick, and Series 300 stainless-steel fasteners.
- RR. Sprayed Polyurethane Foam Sealant: 1- or 2-component, foamed-in-place, polyurethane foam sealant, 1.5 to 2.0 lb/cu. ft 24 to 32 kg/cu. m density; flame spread index of 25 or less according to ASTM E 162; with primer and non-corrosive substrate cleaner recommended by foam sealant manufacturer.
- SS. Modified Bituminous Transition Strip: Vapor-retarding, 40-mil- 1.0-mm- thick, smooth-surfaced, self-adhering; consisting of 36 mils 0.9 mm of rubberized asphalt laminated to a 4-mil- 0.1-mm- thick polyethylene film with release liner backing.
- TT. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low-modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Division 07 Section "Joint Sealants."

3. EXECUTION

12. EXAMINATION

- UU. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
23. Ensure that Work done by other trades is complete and ready.
24. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
25. Verify that concrete has cured and aged for minimum time period recommended by air barrier manufacturer.
26. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
27. Verify that masonry joints are flush and completely filled with mortar.
28. Proceed with installation only after unsatisfactory conditions have been corrected.
29. Notify Architect/Engineer in writing of conditions which may adversely affect system installation or performance. Do not proceed with system installation until these conditions have been corrected

13. SURFACE PREPARATION

- VV. Installer and system manufacturer's representative shall examine substrate to ensure that it is properly prepared and ready to receive system. Manufacturer's representative shall report in writing to Installer and Architect/Engineer conditions which will adversely affect system installation or performance. Do not proceed with installation until these conditions have been corrected
- WW. Proceed with installation only after unsatisfactory conditions have been corrected. Commencing installation constitutes acceptance of work surfaces and conditions.
- XX. Refer to manufacturer's literature for requirements for preparation of substrates. Surfaces shall be sound and free of voids, spalled areas, loose aggregate and sharp protrusions. Remove contaminants such as grease, oil and wax from exposed surfaces. Remove dust, dirt, loose stone and debris. Use repair materials and methods that are acceptable to manufacturer of the fluid-applied air barrier system.
- YY. Exterior sheathing panels: Ensure that the boards are sufficiently stabilized with corners and edges fastened with appropriate screws. Pre-treat all board joints with 50 - 75mm (2-3 in.) wide, manufacturer's recommended self-adhesive tape. Gaps greater than 6mm (1/4 in.) should be filled with mastic or caulk, allowing sufficient time to fully cure before application of the tape and fluid applied air barrier system.
- ZZ. Masonry Substrates: Apply air and vapor barrier over concrete block and brick with smooth trowel-cut mortar joints, struck full and flush. Fill all voids and holes, particularly in the mortar joints, with a lean mortar mix, non-shrinking grout or parge coat.
- AAA. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air barrier application.
- BBB. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- CCC. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- DDD. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate patching membrane.
- EEE. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- FFF. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- GGG. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

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14. JOINT TREATMENT

HHH. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.

30. Prime substrate and apply a single thickness of preparation coat strip extending a minimum of 3 inches 75 mm along each side of joints and cracks. Apply a double thickness of air barrier membrane and embed a joint reinforcing strip in preparation coat.

III. Gypsum Sheathing: Fill joints greater than 1/4 inch 6 mm according to air barrier manufacturer's written instructions.

15. TRANSITION STRIP INSTALLATION

JJJ. Install strips, transition strips, and auxiliary materials according to air barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.

31. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.

32. Install modified bituminous strip on roofing membrane or base flashing so that a minimum of 3 inches 75 mm of coverage is achieved over both substrates.

KKK. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by air barrier sheet in same day. Reprime areas exposed for more than 24 hours.

33. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.

LLL. Connect and seal exterior wall air barrier membrane continuously to roofing membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

MMM. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.

NNN. Apply joint sealants forming part of air barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

OOO. Wall Openings: Prime concealed perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply modified bituminous transition strip so that a minimum of 3 inches 75 mm of coverage is achieved over both substrates. Maintain 3 inches 75 mm of full contact over firm bearing to perimeter frames with not less than 1 inch 25 mm of full contact.

34. Modified Bituminous Transition Strip: Roll firmly to enhance adhesion.

PPP. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air barrier membrane with foam sealant.

QQQ. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

RRR. Seal top of through-wall flashings to air barrier with an additional 6-inch- 150-mm- wide, modified bituminous strip.

SSS. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

TTT. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches 150 mm beyond repaired areas in strip direction.

16. AIR BARRIER MEMBRANE INSTALLATION

UUU. Apply air barrier membrane to form a seal with strips and transition strips and to achieve a continuous air barrier according to air barrier manufacturer's written instructions.

VVV. Apply air barrier membrane within manufacturer's recommended application temperature ranges.

WWW. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by air barrier sheet in same day. Reprime areas exposed for more than 24 hours.

35. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.

XXX. Apply a continuous unbroken air barrier to substrates according to the following minimum thickness. Apply membrane in full contact around protrusions such as masonry ties.

36. Vapor-Permeable Membrane Air Barrier: 3.0-mm Apply to wet film thickness as recommended by manufacturer.

YYY. Apply strip and transition strip a minimum of 1 inch 25 mm onto cured air membrane according to air barrier manufacturer's written instructions.

ZZZ. Do not cover air barrier until it has been tested and inspected by testing agency.

AAAA. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.

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17. FIELD QUALITY CONTROL

- BBBB. Testing Agency: engage a qualified testing agency to perform inspections and prepare reports.
- CCCC. Periodic Inspections: Air barrier materials and installation are subject to inspection for compliance with requirements. Inspections may include the following:
- 37. Continuity of air barrier system has been achieved throughout the building envelope with no gaps or holes.
 - 38. Continuous structural support of air barrier system has been provided.
 - 39. Masonry and concrete surfaces are smooth, clean and free of cavities, protrusions, and mortar droppings.
 - 40. Site conditions for application temperature and dryness of substrates have been maintained.
 - 41. Maximum exposure time of materials to UV deterioration has not been exceeded.
 - 42. Surfaces have been primed, if applicable.
 - 43. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 - 44. Termination mastic has been applied on cut edges.
 - 45. Strips and transition strips have been firmly adhered to substrate.
 - 46. Compatible materials have been used.
 - 47. Transitions at changes in direction and structural support at gaps have been provided.
 - 48. Connections between assemblies (membrane and sealants) have complied with requirements for cleanliness, preparation and priming of surfaces, structural support, integrity, and continuity of seal.
 - 49. All penetrations have been sealed.
- DDDD. Final Inspection: Arrange for air barrier system manufacturer's technical personnel to inspect installation on completion and submit report to Architect/Engineer. Notify Architect/Engineer and Owner's Representative 48 hours in advance of date and time of inspection.
- EEEE. Remove and replace deficient air barrier components and retest as specified above.

18. CLEANING AND PROTECTION

- FFFF. Protect air barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
- 50. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. Remove and replace air barrier exposed for more than 60 calendar days, or manufacturer's recommended exposure time, whichever is less.
 - 51. Protect air barrier from contact with creosote, uncured coal-tar products, TPO, EPDM, flexible PVC membranes, and sealants not approved by air barrier manufacturer.
- GGGG. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
- HHHH. Remove masking materials after installation.

END OF SECTION

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SECTION 079200**JOINT SEALANTS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Preparing substrate surfaces.
- B. Sealant and joint backing.

1.2 REFERENCES

- B. ASTM C790 Use of Latex Sealing Compounds.
- C. ASTM C804 Use of Solvent Release Type Sealants.
- D. ASTM C834 Latex Sealing Compounds.
- E. ASTM C919 Use of Sealants in Acoustical Applications.
- F. ASTM C920 Elastomeric Joint Sealants.
- G. ASTM D1056 Flexible Cellular Materials Sponge or Expanded Rubber.
- H. ASTM D1565 Flexible Cellular Materials Vinyl Chloride Polymers and Copolymers (Open Cell Foam).
- I. SWRI (Sealant, Waterproofing and Restoration Institute) Sealant and Caulking Guide Specification.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide data indicating sealant compliance with specifications, chemical characteristics performance criteria including ASTM reference standards and federal specifications compliance substrate preparation, limitations, and color availability.
- C. Samples: Submit two samples, illustrating full range of sealant colors for selection of range of colors for field samples. Final selections will be made from field samples.
- D. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.
- E. Manufacturer's experience documentation. if manufacturer is not among those listed.
- F. Applicator's experience documentation.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

1.5 QUALIFICATIONS

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- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing the work of this section with minimum three years documented experience approved by manufacturer.

1.6 FIELD SAMPLE

- A. Provide field samples of sealant joints in conjunction with glazing, framing and wall systems, pre-cast concrete panels field sample masonry control joints, and other exterior joints, air barrier system, and pedestrian paving surfaces under provisions of Section 01400.
- B. Apply 24 inch long samples of each specified sealant in colors selected from submittal samples for final color selections.
- C. Locate where directed.
- D. Coordinate Field Sample with field sample components specified in Section 03470 –Tilt-up Precast Concrete, Section 08410 – Aluminum Entrances and Storefronts, Section 08800 – Glazing, and Section 08920 – Glazed Aluminum Curtain Wall System. Contractor must install all components before Field Sample will be reviewed.
- E. Field sample may not remain as part of the Work.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.8 COORDINATION

- A. Coordinate work under provisions of Section 01039.
- B. Coordinate the work with all sections referencing this section.

1.9 WARRANTY

- A. Provide one year warranty under provisions of Section 01700.
- B. Warranty: Include coverage for installed sealants and accessories which fail to achieve air tight seal, water tight seal, and exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.1 SEALANTS

- A. Interior Acrylic Emulsion Latex (Type Iael): ASTM C920, Grade NS, Class 12.5, Use NT; Single component, non staining, non bleeding, non sagging; color as selected.
 - 1. Elongation Capability 2 to 5 percent
 - Service Temperature Range 2 to 160 degrees F
 - 3. Shore A Hardness Range 15 to 40
- B. Butyl Sealant (Type BS): ASTM C920, Grade NS, Use NT single component, solvent release, non skinning, non sagging; black color.
 - 1. Elongation Capability 7 to 10 percent

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- 3. Service Temperature Range -40 to 190 degrees F
- Shore A Hardness Range 24 to 28
- 4. Manufacturers/Products
 - a. Tremco: Butyl
 - b. Protective Treatments, Inc.: 757 butyl
 - c. Substitutions: Under provisions of Section 01600.

C. Elastomeric Sealant, Non-sagging (Type PMCNs).

- 1. Polyurethane Sealant - Multi-Component (Type PMCNs): ASTM C920, Grade NS, Class 25, Use NT, M, A, O; multi component, chemical curing, non staining, non bleeding, non sagging type; color as selected.

- a. Elongation Capability 25 percent
- b. Service Temperature Range 20 to 180 degrees F
- c. Shore A Hardness Range 25 to 35
- d. Manufacturers/Products
 - 1. Pecora: Dynatrol II
 - 2. Sonneborn: Sonolastic NP II
 - 3. Tremco: Dymeric 240-240FC
 - 4. Substitutions: Under provisions of Section 01600.
- 2. Silyl-terminated Polyethers (S & Pe): ASTM C920, Grade NS, Class 25, Use NT, M, A, O; single component, chemical curing, non staining, non bleeding, non sagging; color as selected.
 - a. Movement Capability: +100, -50 percent.
 - b. Elongation Capability 50 percent
 - c. Service Temperature Range 40 to 220 degrees F
 - d. Shore A Hardness Range 20
 - e. Manufacturers/Products
 - 1. Sonneborn: Sonolastic 150

D. Silicone Sealant (Type SNS): ASTM C920, Grade NS, Class 25, Use G, single component, moisture curing, non-staining, non-bleeding, non-sagging type; color as selected;

- 1. Joint movement capability
 - extension +100 percent
 - compression -50 percent
- Temperature range -35 F to 160 F
- Shore A Hardness 15
- 4. Manufacturers/Products
 - a. Dow Corning 756 SMS
 - b. Dow Corning 795
 - c. Tremco: Spectrum 1
 - d. Substitutions: Under provisions of Section 01600

E. Polyurethane Traffic-bearing Sealants, (Type PTB).

- 1. Polyurethane Sealant: ASTM C920, Grade P, Class 25, Use T; single component, chemical curing, non-staining, non-bleeding, capable of continuous water immersion, self-leveling type; color as selected; for slopes less than 1 percent.

- a. Elongation Capability 25 percent
- b. Service Temperature Range 20 to 180 degrees F
- c. Shore A Hardness 35
- d. Manufacturers/Products
 - 1. Mameco: Vulkem 45
 - 2. Pecora: NR-201 Urexpan
 - 3. Sonneborn: Sonolastic SL 1
 - 4. Substitutions: Under provisions of Section 01600.
- 2. Polyurethane Sealant: ASTM C920, Grade P, Class 25, Use T, M, O; multi-component, chemical curing, non-staining, non-bleeding, capable of continuous water immersion, self-leveling type; color as selected:
 - a. Elongation Capability 25 percent:
 - b. Service Temperature Range 20 to 180 degrees F
 - c. Shore A Hardness 25 to 35
 - d. Manufacturers/Products
 - 1. For slopes less than 1 percent

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- a. Mameco: Vulkem 245
 - b. Pecora: NR-200 Urexpan
 - c. Sonneborn: Sonolastic SL2
 - d. Tremco: THC-901
 - e. Substitutions: Under provisions of Section 01600.
2. For slopes of 1 percent or greater
- a. Tremco: THC-901
 - b. Substitutions: Under provisions of Section 01600.

- F. Compressed - Expanding Foam Sealant, (Type EFS): Grade NS, Class 25, Use NT, M, O, precompressed, impregnated, self-expanding, open-cell foam, non-staining, non-bleeding.
1. Elongation Capability 25 percent

- G. Sanitary Silicone Sealant (Type SSS): ASTM C920, Grade NS, Class 25, Use NT, G, A, O single component, conformity to FS-S-001543, FDA Regulation 21 CFR 177.2600 and FDA Food Additive Regulation 121.2514, fungus resistant, acidic curing, non-sagging, non-staining, non-bleeding; translucent white color.
- Shore A Hardness 25

2. Manufacturers/Products
- a) Dow Corning Corp.: 786
 - b) General Electric: SCS 1702
 - c) Tremco: Tremsil 200
 - d) Substitutions: Under provisions of Section 01600.

2.2 ACCESSORIES

- A. Primer: Non staining type, recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non corrosive and non staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint Backing: ASTM D1056; round, closed cell foam rod; oversized 30 to 50 percent larger than joint width; compatible with sealant (polyethylene, butyl, neoprene, polyurethane, PVC).
 - 1. At vertical locations provide polyethylene recommended by sealant manufacturer.
 - 2. At horizontal locations provide solid neoprene or butyl rubber with a Shore A hardness of 70.
- D. Bond Breaker: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces and joint openings are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

- A. Remove loose materials and foreign matter which might impair adhesion of sealant.
- B. Clean and prime joints in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions.
- D. Protect elements surrounding the work of this section from damage or disfiguration.

	079200 JOINT SEALANTS	
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3.3 INSTALLATION

- A. Install sealant in accordance with manufacturer's instructions.
- B. Measure joint dimensions and size materials to achieve required width/depth ratios.
- C. Install joint backing to achieve a neck dimension no greater than 1/3 of the joint width.
- D. Install bond breaker where joint backing is not used.
- E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- G. Tool joints concave.

3.4 CLEANING

- A. Clean work under provisions of 01700.
- B. Clean adjacent soiled surfaces.

3.5 PROTECTION OF FINISHED WORK

- A. Protect finished installation under provisions of Section 01500.
- B. Protect sealants until cured.

3.6 SEALANT SCHEDULE

	Type	Color	
Joints in Building Exterior Skin	PNS and SNS	Field Selected	
Under Thresholds	BS	Black	
Between plumbing fixtures and adjacent finishes	SSS	White	
D. At counters and back splashes with sinks	SSS	Field Selected	
E. In Janitors Closets adjacent to sinks and storage areas for mops and other typically damp items.	SSS	White	
Interior Joints Not Listed Above	IAEL	Field Selected	

	079200 JOINT SEALANTS	
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Joints in Sidewalks PTB Field Selected

Where Detailed EFS Black

Horizontal joints more EFS Black
than 2 inches long and
at the top of exterior
off-site cast
architectural precast
concrete panels walls as
back-up seal

END OF SECTION 079200

	079200 JOINT SEALANTS	
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SECTION 23 05 00 COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1. DEFINITIONS:

- A. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
- B. Option or optional: Contractor's choice of an alternate material or method.

2. RELATED WORK

- A. The requirements of this section relate to all Division 23 sections included with this project.

3. QUALITY ASSURANCE

A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality commercial class products from manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in commercial HVAC systems.

B. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.

C. Products Criteria:

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.

2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.

3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the Project Engineer.

4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

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7. Asbestos products or equipment or materials containing asbestos shall not be used.
- D. Equipment Service Organizations:
 1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and have factory certified technicians on staff.
- E. HVAC Mechanical Systems Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
 1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
 2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
 3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
- F. Execution (Installation, Construction) Quality:
 1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions, the contract drawings and specifications to the Project Engineer for resolution.
 2. Provide complete layout drawings in 1/4" scale minimum, allowing for measured field conditions and interferences. Submitted layout drawings shall be approved by the engineer. Do not commence construction work on any system until the layout drawings have been approved.
4. WARRANTIES
 - A. All equipment, materials and workmanship shall be warrantied against defect for a period of (1) year from the date of substantial completion. Warranties listed herein shall cover the costs associated with the repair or replacement of the defective item or system within a reasonable timeframe.
 - B. Refrigeration compressors shall be warrantied against defect or failure for a period of (5) years from the date of substantial completion. This warranty shall cover the cost of all parts and labor during the warranty period and equipment shall be repaired or replaced at no cost to the owner in a reasonable timeframe.
5. DRAWINGS
 - A. The drawings as included as a part of the construction document package are diagrammatic in nature. They are meant to convey design intent and are not meant to be absolute in their content. It shall be the responsibility of the installing contractor to ensure that all equipment, materials, components and labor are provided as required for a fully functional, code compliant system in accordance with the design intent. Should questions arise or additional clarity be required, the contractor shall issue an RFI in written format to the prime design professional. Written communication will be the only form of correspondence between the design and construction teams and will be the only format by which changes, modifications or clarifications will be formally issued and is the only means by which the construction documents will be

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modified.

6. SUBMITTALS

A. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet the intent of the construction documents. Contractor to ensure that all manufacturer or code required clearances are maintained for all installed equipment. Submittals shall be made as a single submission no later than 45 days after award of construction contract and shall be reviewed and approved by the project General Contractor or CM prior to submitting for approval. Approval of shop drawings or submittals does not constitute an acceptance from the Design Team and does not modify the Contractor's responsibility to provide equipment, materials and workmanship in accordance with the intent of the construction documents. Further, approval does not modify the requirement for the contractor to provide equipment, materials and workmanship as indicated in the contract documents whether it is indicated or discovered in the submittal review process or not. Contractor shall be responsible for providing all equipment, materials and workmanship in accordance with the construction documents regardless of level of approval.

B. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract documents. This contractor shall be responsible for the cost associated with all modifications required as a result of equipment or material substitutions. This shall include the cost associated with all electrical, plumbing, structural and architectural modifications required as a result of the substitution. The Architect and Engineer of Record shall be duly compensated for the cost associated with making these modifications and updating the construction drawings accordingly. Shop drawing or submittal approval does not relinquish the contractor from the responsibility of providing equipment, materials and workmanship in accordance with the general intent of the construction documents and in compliance with all codes and standards in effect at the time of construction. In cases where there is confusion or there appears to be conflicting information contained within the construction documents, the Architect or Engineer of Record shall be consulted through the RFI process and shall make the final determination as to the intent of the construction documents. The contractor shall proceed with the construction process in accordance with the interpretation of the Architect or Project Engineer at no additional cost to the owner

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or project.

C. Prior to submitting shop drawings for approval, contractor shall ensure that manufacturers or vendors of all equipment have each reviewed drawings and specifications and have jointly coordinated and properly integrated their equipment and controls to provide a complete, functional, efficient and code compliant installation in accordance with the intent of the construction documents.

D. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible installation.

E. Coordination Drawings:

1. Submit complete coordinated layout drawings for all new systems, existing systems to be modified and for existing systems that are in the same areas. Coordination drawings shall include all relevant building systems as required to demonstrate a coordinated installation. This shall include all HVAC, electrical, plumbing, structural, architectural and low voltage systems scheduled for installation or modification. Failure for the contractor to submit the required coordination drawings shall indicate that the contractor has taken full responsibility for the cross-discipline coordination effort and is proceeding completely at his own risk. Should the Architect, Engineer or Authority Having Jurisdiction identify any installation, functional, clearance or compliance issues during field observations, the contractor shall provide for remedy of the identified issues completely at his own cost.

2. The coordination drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1/4 inch per foot. Clearly identify and dimension the proposed locations of the principal items of equipment and building systems. The drawings shall clearly show locations and adequate clearance for all equipment, piping, ducting, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems to include all materials, fittings, elbows, access doors, accessories, dampers, control elements, etc.

3. Do not install equipment foundations, equipment or piping until layout drawings have been approved.

4. In addition, for HVAC systems, provide details of the following:

- a) Mechanical equipment rooms.
- b) Hangers, inserts, supports, and bracing.
- c) Pipe sleeves.
- d) Duct or equipment penetrations of floors, walls, ceilings, or roofs.

F. HVAC Maintenance Data and Operating Instructions:

1. Maintenance and operating manuals shall be provided with the project close-out documents.

2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style.

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3. Close-out documentation shall be provided to the owner at the completion of the project. Close-out documentation shall be completely contained within a binder or series of binders and shall include the approved submittals, test & balance report, manufacturer provided O&M manuals, as-built drawings, start-up reports, warranty registrations, warranty contact information, maintenance/repair contact information and complete operating instructions. In addition to the required binders, a complete copy of the close-out documents shall be provided in PDF format on DVD. Unless otherwise noted in the front-end documents or as requested by the owner, a total of (3) sets of close-out documents shall be provided at the completion of the construction process.

G. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.

H. As-built documents shall be prepared using the latest versions of either AutoCAD or REVIT (depending on the software used in the design process) and shall indicate any modifications made during the construction process. An electronic copy of all as-built drawings shall be provided to the Design Team in either (.dwg) format or (.rvt) format upon completion. Both full size printed copies and electronic copies of the as-built drawings shall be provided with the close-out document package. Electronic files shall be stored on DVD and shall be provided with the project close-out documents and shall be provided in PDF format.

I. All close-out documents must be received by the owner and electronic files received by the Design Team prior to approval and release of the final pay-application.

J. APPLICABLE CODES AND STANDARDS

1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

2. Air Conditioning, Heating and Refrigeration Institute (AHRI)
3. American National Standard Institute (ANSI)
4. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
5. National Fire Protection Association (NFPA)
6. International Building Code (IBC) and all relevant sections.
7. All enforced local codes, standards and amendments.

K. DELIVERY, STORAGE AND HANDLING

1. Protection of Equipment:

a) Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the owner has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.

b) Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Resident Engineer. Such repair or replacement shall be at no additional cost to the owner.

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- c) Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
- d) Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.
- L. Cleanliness of Piping and Equipment Systems:
 - 1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
 - 2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
 - 3. Clean interior of all tanks prior to delivery for beneficial use by the owner.
 - 4. Boilers shall be left clean following final internal inspection by owner insurance representative or inspector.
 - 5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.
 - 6. Existing equipment indicated for reuse will be inspected, cleaned and repaired as required to return to service.

M. JOB CONDITIONS – Existing Buildings

- 1. Maintenance of Service: Schedule all work to permit continuous service as required by the owner.
- 2. Phasing of Work: Comply with all requirements shown on drawings or specified.
- 3. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times.
- 4. Maintain the interior of building at 65 degrees F minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes.
- 5. No storm water or ground water leakage permitted.
- 6. Provide daily cleanup of construction and demolition debris on all floor surfaces and on all equipment being operated by the owner.
- 7. Acceptance of Work for Operation: As new facilities are made available for operation and these facilities are of beneficial use, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Project Architect or Engineer will process necessary acceptance and the equipment will then be under the control and operation of owner.

PART 2 PRODUCTS

1. FACTORY-ASSEMBLED PRODUCTS

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- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
- C. All components of an assembled unit need not be products of same manufacturer.
 - 1. Constituent parts that are alike shall be products of a single manufacturer.
 - 2. Components shall be compatible with each other and with the total assembly for intended service.
 - 3. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- D. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- E. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2. COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

3. ELECTRIC MOTORS

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS and the associated electrical sections. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors.
- B. Variable speed motor controllers
 - 1. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. air handlers, fans, pumps, shall be product of a single manufacturer.
 - 2. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor fan sheaves shall be fixed pitch.
 - 3. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.
 - 4. Controller shall be provided with the following operating features and accessories:
 - a) Suitable for variable torque load.

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b) Provide thermal magnetic circuit breaker with external operator and incoming line fuses. Unit shall be rated for minimum 30,000 AIC. Provide AC input line reactors (3% Impedance) on incoming power line. Provide output line reactors on line between drive and motor for motors over 50 HP or where the distance between the breaker and motor exceeds 50 feet.

4. EQUIPMENT AND MATERIALS IDENTIFICATION

A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals.

B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 3/16inch high of brass with blackfilled letters, or rigid black plastic with white letters permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.

C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 3/16inch high riveted or bolted to the equipment.

D. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.

E. Valve Tags and Lists:

1. Valve tags: Engraved black filled numbers and letters not less than 1/2inch high for number designation, and not less than 1/4inch for service designation on 19 gage 11/2 inches round brass disc, attached with brass "S" hook or brass chain.

a) Valve lists: Typed or printed plastic coated card(s), sized 8 1/2 inches by 11 inches showing tag number, valve function and area of control, for each service or system.

b) Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

5. HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

A. Supports for Roof Mounted Items:

1. Equipment Rails: Equipment rails shall be galvanized steel, minimum 18 gauge, with integral baseplate, continuous welded corner seams, factory installed 2" x 4" treated wood nailer, 18 gauge galvanized steel counter flashing cap with screws, builtin cant strip, minimum height 14 inches. For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.

2. Pipe / Duct pedestals: Provide a galvanized Unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.

3. Equipment Pre-fabricated curbs (when not provided by manufacturer): Galvanized steel or extruded aluminum 14 inches above finish roof service, continuous welded corner seams, treated wood nailer (1 1/2 inch thick), 3 pound/cubic feet density rigid mineral fiberboard insulation with metal liner, builtin cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level. Pipe/duct pedestals: Provide a galvanized Unistrut channel welded to Ushaped mounting brackets which are secured to side of rail with galvanized lag bolts.

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4. Pipe Supports: Comply with MSS SP58. Type Numbers specified refer to this standard.
5. Attachment to Concrete Building Construction:
 - a) Concrete insert: MSS SP-58, Type 18.
6. Attachment to Steel Building Construction:
 - a) Welded attachment: MSS SP58, Type 22.
 - b) Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 Cclamp may be used for individual copper tubing up to 7/8inch outside diameter.
7. Hanger Rods: Hotrolled steel, ASTM A36 or A575 for allowable load listed in MSS SP58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turnbuckles shall provide 1 1/2 inches minimum of adjustment and incorporate locknuts. Allthread rods are acceptable.
8. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 15/8 inches by 15/8 inches, No. 12 gage, designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.
 - a) Allowable hanger load: Manufacturers rating less 200 pounds.
 - b) Guide individual pipes on the horizontal member of every other trapeze hanger with 1/4inch Ubolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 1/2inch galvanized steel bands or preinsulated calcium silicate shield for insulated piping at each hanger.
- B. Supports for Piping Systems:
 1. Select hangers sized to encircle insulation on insulated piping. Refer to Mechanical Insulation spec section for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all other types of supports and hangers including those for preinsulated piping.
- C. Piping Systems except High and Medium Pressure Steam (MSS SP58):
 1. Standard clevis hanger: Type 1; provide locknut.
 2. Riser clamps: Type 8.
 3. Wall brackets: Types 31, 32 or 33.
 4. Roller supports: Type 41, 43, 44 and 46.
 5. Saddle support: Type 36, 37 or 38.
 6. Turnbuckle: Types 13 or 15. Preinsulate.
 7. Ubolt clamp: Type 24.
 8. Copper Tube:

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- a) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non adhesive isolation tape to prevent electrolysis.
- b) For vertical runs use epoxy painted or plastic coated riser clamps.
- c) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
- d) Insulated Lines: Provide pre-insulated shields sized for copper tube.
- e) Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.

6. PIPE PENETRATIONS

- A. Install sleeves during construction for other than blocked out floor openings for risers.
- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
 - 1. For sleeves: Extend sleeve one inch above finished floor and provide sealant for watertight joint.
 - 2. For blocked out floor openings: Provide 1 1/2 inch angle set in silicone adhesive around opening.
 - 3. For drilled penetrations: Provide 1 1/2 inch angle ring or square set in silicone adhesive around penetration.
 - 4. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of the Architect.
 - 5. Sheet Metal, Plastic, or Moistureresistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
 - 6. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
 - 7. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
 - 8. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.

7. DUCT PENETRATIONS

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 18 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.

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B. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly.

8. WALL, FLOOR AND CEILING PLATES

A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.

B. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

9. ASBESTOS

A. Materials containing asbestos are not permitted.

PART 3 EXECUTION

1. ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment with other trades. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, lights and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors and control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.

C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.

D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

E. Cutting Holes:

1. Locate holes to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance for coordination purposes. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to the Architect or Structural Engineer for approval.

2. Do not penetrate membrane waterproofing.

F. Interconnection of Instrumentation or Control Devices: Generally, electrical interconnections are not shown but must be provided.

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G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.

H. Electrical Interconnection of Controls and Instruments: This is generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.

I. Protection and Cleaning:

1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items, in the opinion of the Architect or Project Engineer, shall be replaced.

2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

J. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

K. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical equipment. If this is not possible, encase pipe in a second pipe with a minimum of joints and provide a baffle above the electrical equipment sloped to ensure water will run-off away from the electrical equipment. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall be located in the space equal to the width and depth of the equipment and extending from to a height of 6 ft. above the equipment or to the ceiling structure, whichever is lower (NFPA 70).

L. Inaccessible Equipment:

1. Equipment shall be installed with access clearance and access service panels as required by section 306 of the International Mechanical Code, National Electric Code and manufacturer's instructions, whichever is the most stringent. Equipment access shall be provided so that equipment may be removed without removing elements of permanent construction (gypsum board ceilings, plumbing piping, etc.).

2. Where the Architect or Project Engineer determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the owner.

3. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

2. TEMPORARY SYSTEMS AND EQUIPMENT

A. Where required by the construction documents, temporary systems shall be provided to match the capacity of the systems being modified to ensure continuous operations of the space. Temporary systems shall be capable of maintaining the spaces temperature and humidity at levels acceptable to the owner.

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B. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.

C. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress and shall be insulated where injury can occur to personnel by contact with operating facilities.

D. Temporary facilities and piping shall be completely removed and any openings in structures sealed/finished to match existing. Provide necessary blind flanges and caps to seal open piping remaining in service.

3. RIGGING

A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.

B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by the owner under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.

C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for owner operation and maintenance of service.

D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.

E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

F. Restore building and surroundings to original condition upon completion of rigging work.

4. PIPE AND EQUIPMENT SUPPORTS

A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Architect or Structural Engineer.

B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.

C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 1/2inch clearance between pipe or piping covering and adjacent work.

D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP69 and relevant codes. Provide additional supports at valves, strainers, inline pumps and other heavy components. Provide a support within one foot of each elbow.

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E. HVAC Vertical Pipe Supports:

1. Up to 6 inch pipe, 30 feet long, bolt riser clamps to the pipe below couplings or welded to the pipe and rests supports securely on the building structure.
2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.

F. Overhead Supports:

1. Contractor shall confirm that the basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.

G. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating conditions, seismic conditions (if applicable), and to withstand design wind pressures without excessive displacement or structural failure.
2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment plus 3 inch excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 6 inches on all sides. Refer to structural drawings. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.

5. MECHANICAL DEMOLITION

A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor after approval for structural integrity by the Architect or Structural Engineer. Such access shall be provided without additional cost or time to the owner. Where work is in an operating facility, provide approved protection from dust and debris at all times.

B. In an operating facility, maintain the operation, cleanliness and safety. Personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit debris to accumulate in the area to the detriment of operations. Perform all flame cutting to maintain the fire safety integrity of the facility. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards.

C. Completely remove all ducting, piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained.

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D. Owner shall receive first right of refusal for all demolished equipment and materials. Should the owner refuse, the contractor shall dispose of demolished equipment in a proper manner. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from the property expeditiously and shall not be allowed to accumulate..

6. CLEANING AND PAINTING

A. Prior to final inspection and acceptance of the facilities for beneficial use by the owner, the facilities, equipment and systems shall be thoroughly cleaned and painted.

B. In addition, the following special conditions apply:

1. Cleaning shall be thorough. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.

C. Material And Equipment Not To Be Painted Includes:

1. Motors, controllers, control switches, and safety switches.
2. Control and interlock devices.
3. Regulators.
4. Pressure reducing valves.
5. Control valves and thermostatic elements.
6. Lubrication devices and grease fittings.
7. Copper, brass, aluminum, stainless steel and bronze surfaces.
8. Valve stems and rotating shafts.
9. Pressure gauges and thermometers.
10. Glass.
11. Name plates.

D. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.

E. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer

F. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.

G. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.

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H. Any exposed piping, ducting or equipment shall be completely painted. Colors shall be consistent with industry standards or as the owner wishes. All exterior equipment, piping or ducting shall be painted with a corrosion resistant finish compatible with the painted material and as recommended by the manufacturer.

7. MOTOR AND DRIVE ALIGNMENT

A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane. Provide belt and sheave replacements as required to achieve test and balance at no additional cost to project.

B. Directconnect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

8. LUBRICATION

A. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.

B. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

9. COMMISSIONING (If Required)

A. Provide commissioning documentation and assist in the commissioning process as required by the commissioning plan and as requested by the commissioning agent. Contractor shall read and understand the requirements of the commissioning plan prior to executing the construction contract.

10. STARTUP AND TEMPORARY OPERATION

A. Start-up equipment as described in equipment specifications. All HVAC equipment shall be provided with factory start-up performed by the equipment manufacturer. Start-up sheets shall be included with the close-out documentation. Verify that vibration is within specified tolerance prior to extended operation.

11. OPERATING AND PERFORMANCE TESTS (If Required)

A. Should evidence of malfunction in any tested system or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the owner.

B. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made prior to performance tests, performance tests for heating and cooling systems shall be completed during first actual seasonal use of respective systems following completion of work.

End of Section

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SECTION 23 05 12 GENERAL MOTOR REQUIREMENTS

PART 1 GENERAL

1. DESCRIPTION:

A. This section specifies the furnishing, installation and connection of motors for all HVAC, plumbing and fire protection equipment.

2. SUBMITTALS:

A. Shop Drawings:

1. Provide documentation to demonstrate compliance with drawings and specifications.

2. Include electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.

B. Manuals:

1. Submit simultaneously with the shop drawings, companion copies of complete installation, maintenance and operating manuals, including technical data sheets and application data.

PART 2 PRODUCTS

1. MOTORS:

A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply.

B. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors as scheduled. unless otherwise specified for a particular application, use electric motors with the following requirements.

C. Singlephase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide starter. Provide capacitor-start type for hard starting applications.

1. Electrically Commutated motor (ECM Type): Motor shall be brushless DC type specifically designed for applications with heavy duty ball bearings and electronic commutation. The motor shall be speed controllable down to 20% of full speed and 85% efficient at all speeds.

D. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Provide starter.

1. Two Speed Motors: Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.

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E. Motors shall be designed for operating the connected loads continuously in a 40°C (104°F) environment, where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation. If the motors exceed 40°C (104°F), the motors shall be rated for the actual ambient temperatures.

F. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.

G. Motor Enclosures:

1. Shall be the NEMA types as specified and/or shown on the drawings.
2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed. Enclosure requirements for certain conditions are as follows:
 - a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
 - b. Where motors are located in an NEC 511 classified area or in areas with explosive materials, provide TEFC explosion proof motor enclosures.
 - c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.

H. Special Requirements:

1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the owner.
2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification and the manufacturer's written installation material.
3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
 - a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
 - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
 - c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.

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4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on all HVAC, plumbing and fire equipment shall be sized for non-overloading at all points on the performance curves.

5. Motors utilized with variable frequency drives shall be rated "inverter-duty" per NEMA Standard, MG1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.

I. EnergyEfficient Motors (Motor Efficiencies): All permanently wired motors of (1) HP or more shall meet the minimum full-load efficiencies as indicated in the following table. Motors of (1) HP or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors not specified as "premium efficiency" shall comply with the Energy Policy Act of 2005 (EPACT).

Minimum Premium Efficiencies Open Drip-Proof				Minimum Premium Efficiencies Totally Enclosed Fan-Cooled			
Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM	Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

J. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM.

PART 3 – EXECUTION

1. INSTALLATION:

A. Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.

2. FIELD TESTS:

A. Perform an electric insulation resistance test using a megohmmeter on all motors after installation, before start-up. All shall test free from grounds.

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B. Perform Load test in accordance with ANSI/IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.

C. Insulation Resistance: Not less than onehalf meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

3. **STARTUP AND TESTING:**

A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

4. **COMMISSIONING (IF REQUIRED):**

A. Provide commissioning documentation in accordance with the requirements of the Commissioning Plan for all inspection, start up, and contractor testing required above and required by the Commissioning Agent.

B. Components provided under this section of the specification will be tested as part of a larger system.

End of Section

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SECTION 23 05 40 NOISE AND VIBRATION CONTROL

PART 1 – GENERAL

1. DESCRIPTION:

A. Noise criteria, seismic restraints for equipment, vibration tolerance and vibration isolation for HVAC, plumbing and fire protection work.

B. Noise Criteria:

1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed following NC levels:

TYPE OF ROOM	NC LEVEL
Auditoriums, Theaters	20
Bathrooms and Toilet Rooms	30
Chapels	25
Conference Rooms	25
Corridors(Public)	30
Dining Rooms, Food Services/ Serving	30
Guest Rooms	25
Gymnasiums	40
Kitchens	40
Laundries	40
Living Areas	25
Lobbies, Waiting Areas	30
Locker Rooms	35
Offices, Large Open	30
Offices, Small Private	25
Patient Rooms	25
Private Dwellings	25
Recreation Rooms	40
Shops	50
Warehouse	50

2. For equipment which has no sound power ratings scheduled on the plans, the contractor shall select equipment such that the fore-going noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook, Chapter 7, Sound and Vibration.

3. An allowance, not to exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as, furniture.

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This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.

4. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.

C. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

2. SUBMITTALS:

A. Manufacturer's Literature and Data:

1. Vibration isolators:

- a. Floor mountings
 - b. Hangers
 - c. Snubbers (if required)
 - d. Thrust restraints (if required)
2. Bases.

3. Acoustical enclosures.

B. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.

C. Detailed design of the materials and components included in this section shall be considered as a delegated design submittal. The manufacturer of these components shall provide signed and sealed design drawings and calculations prepared by a registered engineer in the state where the project is being constructed with the submittal information. The design and calculations shall be in accordance with the requirements of the building code in enforce at the time of project permitting and shall be completed in accordance with the seismic category and zone if applicable.

PART 2 - PRODUCTS

1. GENERAL REQUIREMENTS:

A. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.

B. Elastometric Isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.

C. Exposure to weather: Isolator housings to be either hot dipped galvanized or powder coated to ASTM B117 salt spray testing standards. Springs to be powder coated or electro galvanized. All hardware to be electro galvanized. In addition provide limit stops to resist wind velocity. Velocity pressure established by wind shall be calculated in accordance with the enforced building code. A minimum wind velocity of 75 mph shall be employed.

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D. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.

E. Color code isolators by type and size for easy identification of capacity.

2. VIBRATION ISOLATORS:

A. Floor Mountings:

1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.

2. Spring Isolators (Type S): Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.

3. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators noted above, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement and spring extension due to wind loads. Provide clearance around restraining bolts to prevent mechanical short circuiting.

4. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be natural rubber or neoprene waffle, neoprene and steel waffle, or reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).

5. Seismic Pad (Type DS): Pads shall be natural rubber / neoprene waffle with steel top plate and drilled for an anchor bolt. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).

B. Hangers:

1. Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.

2. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.

3. Spring Position Hanger (Type HP): Similar to combination neoprene and spring hanger except hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.

4. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.

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5. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.

6. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.

7. Hangers used in seismic applications shall be provided with a neoprene and steel rebound washer installed $\frac{1}{4}$ ' clear of bottom of hanger housing in operation to prevent spring from excessive upward travel.

3. BASES:

A. Inertia Base: All base mounted pumps shall be provided with grouted inertia bases. Base shall be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating prelocated equipment anchor bolts and pipe sleeves. Level the concrete to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Channel depth shall be a minimum of 1/12 of longest dimension of base but not less than 150 mm (six inches). Form shall include 13-mm (1/2-inch) reinforcing bars welded in place on minimum of 203 mm (eight inch) centers running both ways in a layer 40 mm (1-1/2 inches) above bottom. Use height saving brackets in all mounting locations. Weight of inertia base shall be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 2 mm (1/16 inch).

B. Curb Mounted Isolation Base: Equipment scheduled with isolation curbs shall be provided with this type of base. Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 6 mm (1/4 inch) clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

PART 3 - EXECUTION

1. INSTALLATION:

A. Vibration Isolation:

1. No metal-to-metal contact will be permitted between fixed and floating parts.

2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports with a deflection equal to that used on the corresponding equipment.

3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.

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4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (100 degrees F).
 5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
 6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.
 7. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.
2. ADJUSTING
- A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.
 - B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
 - C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4inch (6-mm) movement during start and stop.
 - D. Adjust active height of spring isolators.
 - E. Adjust snubbers according to manufacturer's recommendations.
 - F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
 - G. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

End of Section

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SECTION 23 05 90
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1. DESCRIPTION:

A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:

1. Planning systematic TAB procedures.
2. Design Review Report.
3. Systems Inspection report.
4. Duct Air Leakage test report.
5. Systems Readiness Report.
6. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
7. Vibration and sound measurements.
8. Recording and reporting results.

9. Exemptions:

a. Mechanical systems for projects that serve dwelling units and sleeping units in hotels, motels, boarding houses or similar units. Note that outdoor air systems and exhaust systems must still be balanced on all projects to meet the project's enforced mechanical code.

B. Definitions:

1. Basic TAB used in this Section: Chapter 37, "Testing, Adjusting and Balancing" of 2007 ASHRAE Handbook, "HVAC Applications".
2. AABC: Associated Air Balance Council.
3. NEBB: National Environmental Balancing Bureau.
4. Hydronic Systems: Includes chilled water, condenser water, heating hot water, domestic hot water circulating systems and pumped domestic water supply systems.
5. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.

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2. QUALITY ASSURANCE:

A. Qualifications:

1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.

2. The TAB agency shall be either a certified member of AABC or certified by the NEBB to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Architect and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding contract award shall not be eligible to perform any work related to the TAB. All work performed in this section and in other related sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.

3. TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Architect and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding contract award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this section and in other related sections performed by the TAB Specialist shall be considered invalid if the TAB Specialist loses its certification prior to contract completion and must be performed by an approved successor.

4. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:

- a. Shall directly supervise all TAB work.
- b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB.
- c. Would follow all TAB work through its satisfactory completion.
- d. Shall provide final markings of settings of all HVAC adjustment devices.
- e. Permanently mark location of duct test ports.

5. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing. The lead technician shall be certified by AABC or NEBB.

6. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing,

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Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.

7. Tab Criteria:

a. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 36, and requirements stated herein shall be the basis for planning, procedures, and reports.

b. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "HVAC Applications", Chapter 36, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop values for pre-filters and after-filters.

c. Air handling unit and all other fans, (cubic feet per minute): Minus 0 percent to plus 10 percent.

d. Air terminal units (maximum values): Minus 2 percent to plus 10 percent.

e. Exhaust hoods/cabinets: 0 percent to plus 10 percent.

f. Minimum outside air: 0 percent to plus 10 percent.

g. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 5 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be minus 5 to plus 5 percent.

h. Heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.

i. Chilled water and condenser water pumps: Minus 0 percent to plus 5 percent.

j. Chilled water coils: Minus 0 percent to plus 5 percent.

k. Domestic water circulation and booster systems: Minus 5 percent to plus 5 percent.

3. SUBMITTALS

A. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment with calibration reports.

B. Submit Following for Review and Approval:

1. Design Review Report within 90 days for conventional design projects and within 60 days for design-build projects.

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2. Systems inspection report on equipment and installation for conformance with design.
3. Duct Air Leakage Test Report.
4. Systems Readiness Report.
5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
- C. Prior to request for Final or Substantial Completion inspection, submit completed Test and Balance report for the area.
4. **APPLICABLE PUBLICATIONS:**
 - A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.
 - B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE): 2007 HVAC Applications ASHRAE Handbook, Chapter 37, Testing, Adjusting, and Balancing and Chapter 47, Sound and Vibration Control.
 - C. Associated Air Balance Council (AABC): 2002 AABC National Standards for Total System Balance.
 - D. National Environmental Balancing Bureau (NEBB): 7th Edition 2005 Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems. 2nd Edition 2006 Procedural Standards for the Measurement of Sound and Vibration. 3rd Edition 2009 Procedural Standards for Whole Building Systems Commissioning of New Construction.
 - E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): 3rd Edition 2002 HVAC SYSTEMS Testing, Adjusting and Balancing.

PART 2 – PRODUCTS

1. **PLUGS:**
 - A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

PART 3 – EXECUTION

1. **GENERAL:**
 - A. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

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2. DESIGN REVIEW REPORT:

A. The TAB Specialist shall review the Contract Plans and specifications and advise the Architect of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

3. SYSTEMS INSPECTION REPORT:

A. Inspect equipment and installation for conformance with design.

B. The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.

C. Reports: Follow check list format developed by AABC, NEBB or SMACNA, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

4. DUCT AIR LEAKAGE TEST REPORT:

TAB Agency shall perform the leakage test as outlined in the duct system specification for agency's role and responsibilities in witnessing, recording and reporting of deficiencies.

5. SYSTEM READINESS REPORT:

A. The TAB Contractor shall measure existing air and water flow rates associated with existing systems utilized to serve renovated areas as indicated on drawings. Submit report of findings to Architect

B. Inspect each system to ensure that it is complete including installation and operation of controls. Submit report to Architect in standard format and forms prepared and or approved by the Commissioning Agent if applicable.

C. Verify that all items such as ductwork, piping, ports, terminals, connectors, etc., that are required for TAB are installed. Provide a report to the Architect.

6. TAB REPORTS:

A. Submit an intermediate report for 25 percent of systems and equipment tested and balanced to establish satisfactory test results.

B. The TAB contractor shall provide raw data in writing to the Architect if there is a problem in achieving intended results before submitting a formal report.

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C. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated and re-submitted for approval at no additional cost to the owner.

D. Do not proceed with the remaining systems until intermediate report is approved by the Architect.

7. TAB PROCEDURES:

A. Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC or NEBB.

B. General: During TAB, all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.

C. Coordinate TAB procedures with existing systems and any phased construction completion requirements for the project. Provide TAB reports for pre-construction air and water flow rate and for each phase of the project prior to partial final inspections of each phase of the project. Return existing areas outside the work area to pre constructed conditions.

D. Air Balance and Equipment Test: Include air handling units, fans, terminal units, fan coil units, room diffusers/outlets/inlets, computer room AC units, and laboratory fume hoods and biological safety cabinets. Include all supply, return and exhaust systems as well as outdoor air systems. Kitchen exhaust and make-up systems shall be balanced as well.

1. Artificially load air filters by partial blanking to produce air pressure drop of manufacturer's recommended pressure drop.

2. Adjust fan speeds to provide design air flow. Provide for belt and sheave replacements as required to achieve design flow rates.

3. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other controls function properly.

E. Water Balance and Equipment Test: Include chillers, pumps, convertors, coils, coolers and condensers:

1. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.

2. Variable Volume Systems: Balance systems at design water flow and verify that variable flow controls function as designed.

3. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for convertors. Include flow rates, pressure drops, filter differential pressure and entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.

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8. VIBRATION TESTING:

- A. Furnish instruments and perform vibration measurements as specified. Provide measurements for all rotating HVAC equipment of 1/2 horsepower and larger, including centrifugal/screw compressors, cooling towers, pumps, fans and motors.
- B. Record initial measurements for each unit of equipment on test forms and submit a report to the Architect. Where vibration readings exceed the allowable tolerance, Contractor shall be directed to correct the problem. The TAB agency shall verify that the corrections are done and submit a final report to the Architect.

9. SOUND TESTING:

- A. Perform and record required sound measurements as indicated herein.
- B. Take readings in rooms, approximately ten percent of all rooms. The Architect may designate the specific rooms to be tested.
- C. Provide cooling tower sound measurements as indicated.
- D. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC or NEBB.
- E. Sound reference levels, formulas and coefficients shall be according to ASHRAE Handbook, "HVAC Applications", Chapter 46, SOUND AND VIBRATION CONTROL.
- F. Where measured sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the Architect and the necessary sound tests shall be repeated.
- G. Test readings for sound testing could go higher than 10 percent if determination is made by the Architect based on the recorded sound data.

10. MARKING OF SETTINGS:

- A. Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be high contrast in color and permanent.

11. IDENTIFICATION OF TEST PORTS:

- A. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

12. PHASING:

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A. Phased Projects: Testing and Balancing Work to follow project with areas shall be completed per the project phasing. Upon completion of the project all areas shall have been tested and balanced per the contract documents.

B. Existing Areas: Systems that serve areas outside of the project scope shall not be adversely affected. Measure existing parameters where shown to document system capacity.

13. COMMISSIONING:

A. Provide commissioning documentation in accordance with the requirements of the commissioning plan for all inspection, start up, and contractor testing required above and required by the Commissioning Agent.

End of Section

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SECTION 23 07 10 MECHANICAL INSULATION

PART 1 – GENERAL

1. DESCRIPTION:

A. Field applied insulation for thermal efficiency and condensation control for HVAC piping, ductwork and equipment.

B. Definitions:

1. ASJ: All service jacket, white finish facing or jacket.
2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
3. Cold: Equipment, ductwork or piping handling media at design temperature of 60 degrees F or below.
4. Concealed: Ductwork and piping above ceilings and in chases, interstitial space, and pipe spaces.
5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including equipment rooms or exposed to outdoor weather. Shafts, chases, interstitial spaces, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
6. FSK: Foilsclrimkraft facing.
7. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permance of 0.1 perms and vapor barriers shall have a maximum published permance of 0.001 perms.
8. Hot: HVAC Ductwork handling air at design temperature above 60 degrees F; HVAC equipment or piping handling media above 105 degrees F; boiler breechings, generator exhaust, grease hood exhaust, clothes dryer exhaust, and piping and equipment 90 to 450 degrees F.
9. Density: Pcf - pounds per cubic foot.
10. Runouts: Branch pipe connections up to one-inch nominal size to fan coil units or reheat coils for terminal units.
11. Thermal conductance: Heat flow rate through materials.
 - a. Flat surface: BTU per hour per square foot.
 - b. Pipe or Cylinder: BTU per hour per linear foot.
12. Thermal Conductivity (k): BTU per inch thickness, per hour, per square foot, per degree F temperature difference.
13. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permance of 0.1 perms and vapor barriers shall have a maximum published permance of 0.001 perms.

2. QUALITY ASSURANCE:

A. Criteria:

1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, UL 181A, UL181B, ASTM C 411, ASTM E84, UL 723, or NFPA 255. Comply with SMACNA, ASHRAE and the codes in effect at the time of permitting.

B. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

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C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

D. Where system components or equipment are found to be producing condensation, contractor shall re-insulate or add additional insulation as required to prohibit the formation of condensation.

E. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.

1. American Society for Testing and Materials (ASTM):
2. B209-2014 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
3. C411-2011 Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
4. C449-2007 (R2013) Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
5. C450-2008 (R2014) Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
6. Adjunct to C450 Compilation of Tables that Provide Recommended Dimensions for Prefab and Field Thermal Insulating Covers, etc.
7. C533-2013 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
8. C534/C534M-2014 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
9. C547-2015 Standard Specification for Mineral Fiber Pipe Insulation
10. C552-2014 Standard Specification for Cellular Glass Thermal Insulation
11. C553-2013 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
12. C591-2013 Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
13. C680-2014 Standard Practice for Estimate of the Heat Gain or Loss and the Surface Temperatures of Insulated Flat, Cylindrical, and Spherical Systems by Use of Computer Programs
14. C612-2014 Standard Specification for Mineral Fiber Block and Board Thermal Insulation
15. C1126-2014 Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
16. C1136-2012 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
17. C1710-2011 Standard Guide for Installation of Flexible Closed Cell Preformed Insulation in Tube and Sheet Form
18. D1668/D1668M1997a (2014)e1 Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
19. E84-2015a Standard Test Method for Surface Burning Characteristics of Building Materials
20. E2231-2015 Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation to Assess Surface Burning Characteristics
21. National Fire Protection Association (NFPA) 90A-2015 Standard for the Installation of Air-Conditioning and Ventilating Systems
22. Underwriters Laboratories, Inc (UL):
 - i. 723-2008 (R2013) Standard for Test for Surface Burning Characteristics of Building Materials
 - ii. 1887-2004 (R2013) Standard for Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics

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3. SUBMITTALS:

A. Shop Drawings:

All information, clearly presented, shall be included to determine compliance with drawings and specifications

1. Insulation materials: Specify each type used and state surface burning characteristics.
2. Insulation facings and jackets: Each type used. Submittal shall clearly indicate proposed finishes for exposed ductwork, casings, pipe and equipment.
3. Insulation accessory materials: Each type used.
4. Make reference to applicable specification paragraph numbers for coordination.

4. STORAGE AND HANDLING OF MATERIAL:

A. Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

PART 2 PRODUCTS

1. MINERAL FIBER OR FIBER GLASS (INTERIOR):

A. ASTM C612 (Board, Block), Class 1 or 2, density 3 pcf, $k = 0.26$ at 75 degrees F, external insulation for temperatures up to 400 degrees F with foil scrim (FSK) facing. Contractor shall select thickness so that installed insulation meets minimum R value required.

B. ASTM C553 (Blanket, Flexible) Type I, Class B-5, Density 2 pcf, $k = 0.27$ at 75 degrees F, for use at temperatures up to 400 degrees F with foil scrim (FSK) facing.

C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, $k = 0.26$ at 75 degrees F, for use at temperatures up to 450 degrees F with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

2. RIGID DUCT BOARD (EXTERIOR):

A. Rigid glass fiber board; ANSI/ASTM C612; commercial grade; 8.0 installed 'R' value (minimum) at 75 degrees F, foil scrim kraft facing for air conditioning ducts (nominally 2" thick) exposed to the weather. Provide with aluminum weather proof jacketing and ensure that tops of ducts are 'tented' to prohibit the ponding of water. All seams in insulation and jacket shall be sealed water tight. Insulation shall be equal to Certainteed, Certapro Commercial Board with FSK facing, type CB 300 (3.0 lb/cu.ft.) minimum density.

3. CELLULAR GLASS CLOSED-CELL:

A. Comply with Standard ASTM C552, density 7.5 pcf nominal, $k = 0.29$ at 75 degrees F.

B. Pipe insulation for use at process temperatures below ambient air to 900 degrees F with all service vapor retarder jacket (ASJ).

C. Pipe insulation for use at process temperatures for pipe and tube below ambient air temperatures or where condensation control is necessary are to be installed with a vapor retarder/barrier system of with all service vapor retarder sealed jacket (ASJ) system.

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4. FLEXIBLE ELASTOMERIC CELLULAR THERMAL:

A. ASTM C534/C534M, $k = 0.27$ at 75 degrees F, flame spread not over 25, smoke developed not over 50, for temperatures from 40 degrees F to 199 degrees F. Under high humidity exposures for condensation control an external vapor retarder/barrier jacket is required. Consult ASTM C1710.

5. INSULATION FACINGS AND JACKETS:

A. Vapor Retarder, high strength with low water permeance = 0.02 or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.

B. ASJ jacket shall be white kraft bonded to 1 mil thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 1-1/2 inch lap on longitudinal joints and minimum 3 inch butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.

C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: FoilScrimKraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.

D. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork as well as on interior piping and ductwork exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) in high humidity areas conveying fluids below ambient temperature. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 30 inch-pounds for interior locations and (80 inch-pounds for exterior or exposed locations or where the insulation is subject to damage.

E. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to composition A, Type II Grade GU, and Type III, minimum thickness 0.03 inches. Provide color matching vapor retarder pressure sensitive tape.

F. Aluminum Jacket-Piping systems and circular breeching and stacks: ASTM B209, 3003 alloy, H-14 temper, 0.023 inch minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.024 inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 0.5 inch wide on 18 inch centers. System shall be weatherproof if utilized for outside service.

6. PIPE COVERING PROTECTION SADDLES:

A. Pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass insulation of the same thickness as adjacent insulation.

B. Pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation.

C. Pipe supports: MSS SP58, Type 39. Apply at all pipe support points, except where MSS SP58, Type 3 pipe clamps provided as part of the support system.

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Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size (inches)	Insert Blocks (inches)
Up through 5	6 long
6	6 long
8, 10, 12	9 long
14, 16	12 long
18 through 24	14 long

7. ADHESIVE, MASTIC, CEMENT:

- A. As recommended by insulation manufacturers' published recommendations.
- B. Low VOC in accordance with LEED requirements.

8. MECHANICAL FASTENERS:

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steelcoated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching galvanized steel.
- C. Wire: 18 gage soft annealed galvanized or 14 gage copper clad steel or nickel copper alloy.
- D. Bands: 0.5 inch nominal width, brass, galvanized steel, aluminum or stainless steel.

9. REINFORCEMENT AND FINISHES:

- A. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.
- B. PVC fitting cover: Composition A, 1186 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 40 degrees F to 250 degrees F. Provide color matching vapor barrier pressure sensitive tape.

10. FLAME AND SMOKE:

- A. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications.

PART 3 – EXECUTION

1. GENERAL REQUIREMENTS:

- A. Required pressure tests of duct and piping joints and connections shall be completed. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.

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C. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems. Lap and seal vapor retarder over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 6 inches.

D. Install vapor stops with operating temperature 60 degrees F and below at all insulation terminations on either side of valves, pumps, fittings, and equipment and particularly in straight lengths every 15 to 20 feet of pipe insulation. The annular space between the pipe and pipe insulation of approx. 1 inch in length at every vapor stop shall be sealed with appropriate vapor barrier sealant.

E. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 20 gage galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.

F. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.

G. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable. Duct systems shall be tented on the top surface to ensure positive drainage of water from the surface.

H. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.

I. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow and fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting.

J. Firestop Pipe and Duct insulation: Provide firestopping insulation at fire and smoke barriers through penetrations. All penetrations through rated assemblies will require fire stopping with a U.L. approved firestopping method.

K. Freeze protection of above grade outdoor piping over heat tracing tape: 1.5" thick cellular glass insulation for all pipe sizes. Provide metal jackets for all pipes. Provide for cold water make-up, condenser water piping, chilled water piping, drain piping at traps and other wetted pipe as required to prohibit freezing.

L. Provide vapor barrier jackets over insulation as follows: All piping and duct systems shall be provided with an integral vapor barrier unless noted otherwise.

M. Provide metal jackets over insulation as follows:

1. All plumbing piping exposed to outdoor weather.
2. Piping exposed in building, within 6 feet of the floor, that connects to sterilizers, kitchen and laundry equipment, piping in equipment rooms and piping drops subject to damage (janitor closets, etc.). Jackets may be applied with pop rivets except for cold pipe or tubing applications. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.

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3. A 2 inch jacket overlap is required at longitudinal and circumferential joints with the overlap at the bottom.

N. Provide PVC jackets over insulation as follows:

1. Piping exposed in building, within 6 feet of the floor, on piping that is not precluded in previous sections. PVC Jackets is not permitted in areas where pipe is subject to damage. PVC jackets may not be used on exterior piping.
2. A 2 inch jacket overlap is required at longitudinal and circumferential joints with the overlap at the bottom.

2. INSULATION INSTALLATION:

A. Mineral Fiber Board and Rigid Duct Board:

1. Apply board on pins spaced not more than 12 inches on center each way, and not less than 3 inches from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
2. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and attics, interstitial spaces and duct work exposed to outdoor weather:
 - i. 2 inch thick insulation faced with ASJ (white all service jacket): Supply air duct, return air duct, mixed air plenums and prefilter housing.
 - ii. Outside air intake ducts: one inch thick insulation faced with ASJ.
 - iii. Exposed, unlined supply and return ductwork exposed to outdoor weather: 2 inch thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer vapor barrier with a maximum water vapor permeability of 0.001 perms.
 3. Supply air duct in the warehouse and in the laundry: one inch thick insulation faced with ASJ.
 4. Chilled water pumps: Insulate with removable and replaceable 20 gage aluminum or galvanized steel covers lined with insulation. Seal closure joints/flanges of covers with gasket material. Fill void space in enclosure with flexible mineral fiber insulation.
 5. Flexible Mineral Fiber Blanket: Adhere insulation to metal with 3 inch wide strips of insulation bonding adhesive at 8 inches on center all around duct. Additionally secure insulation to bottom of ducts exceeding 24 inches in width with pins welded or adhered on 18 inch centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.
 6. Molded Mineral Fiber Pipe and Tubing Covering: Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on ducts and piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports.
 7. Cellular Glass Insulation: Pipe and tubing, covering nominal thickness as specified in the schedule at the end of this section. Install per manufacturer's instructions.
 8. Cold equipment: 2 inch thick insulation faced with ASJ for chilled water pumps, water filters, chemical feeder pots or tanks, expansion tanks, buffer tanks, air separators and air purgers.
 9. Hot equipment: 1-1/2 inch thick insulation faced with ASJ.
 - i. Convertors, air separators, steam condensate pump receivers.
 - ii. Reheat coil casing and separation chambers on steam humidifiers located above ceilings.
 - iii. Domestic water heaters and hot water storage tanks (not factory insulated).
 - iv. Booster water heaters.
 10. Flexible Elastomeric Cellular Thermal Insulation: Apply insulation and fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
 - i. Pipe and tubing insulation: Use proper size material. Do not stretch or strain insulation.

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- ii. Where possible, slip insulation over the pipe or tubing prior to connection and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.
 - iii. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
 - 11. Duct Wrap for Kitchen Hood Grease Ducts: The insulation thickness, layers and installation method shall be as per recommendations of the manufacturer to maintain the fire integrity and performance rating. Maintain 2 hour rated assembly with zero clearance. Provide stainless steel jacket for all exterior and exposed interior ductwork.
 - 12. Laundry: Hot exhaust ducts from dryers and from ironers, where duct is exposed in the laundry.
- B. Flexible Mineral Fiber Blanket:**
- 1. Adhere insulation to metal with 3 inch wide strips of insulation bonding adhesive at 8 inches on center all around duct. Additionally secure insulation to bottom of ducts exceeding 24 inches in width with pins welded or adhered on 18 inch centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.
 - 2. Supply air ductwork to be insulated includes main and branch ducts from AHU discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate sound attenuator units, coil casings and damper frames. To prevent condensation insulate trapeze type supports and angle iron hangers for flat oval ducts that are in direct contact with metal duct.
 - 3. Concealed supply air ductwork.
- i. Above ceilings at a roof level, in attics, and duct work exposed to outdoor weather: 2 inch thick insulation faced with FSK.
 - ii. Above ceilings for other than roof level: 1 ½ inch thick insulation faced with FSK.
 - 4. Concealed return air duct:
 - i. In attics (where not subject to damage) and where exposed to outdoor weather: 2 inch thick insulation faced with FSK,
 - ii. Above ceilings at a roof level, unconditioned areas, and in chases with external wall or containing steam piping: 1-1/2 inch thick, insulation faced with FSK.
 - iii. In interstitial spaces (where not subject to damage): 1-1/2 inch thick insulation faced with FSK.
 - 5. Concealed outside air duct: 1-1/2 inch thick insulation faced with FSK.
- C. Molded Mineral Fiber Pipe and Tubing Covering:**
- 1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
 - 2. Contractor's options for fitting, flange and valve insulation:
 - i. Insulating and finishing cement for sizes less than 4 inches operating at surface temperature of 60 degrees F or more.
 - ii. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 40 degrees F, or above 250 degrees F. Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
 - iii. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 60 degrees F or less, vapor seal with a layer of glass fitting tape imbedded between two 1/16 inch coats of vapor barrier mastic.
 - iv. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 2 inches.
 - 3. Nominal thickness specified in the schedule at the end of this section.

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D. Flexible Elastomeric Cellular Thermal Insulation:

1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.

2. Pipe and tubing insulation:

i. Use proper size material. Do not stretch or strain insulation.

ii. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer.

3. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slipon technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.

4. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.

5. Pipe insulation: nominal thickness in inches as specified in the schedule at the end of this section.

6. Use Class S (Sheet), 3/4 inch thick for the following:

i. Chilled water pumps

ii. Bottom and sides of metal basins for winterized cooling towers (where basin water is heated).

iii. Chillers, insulate any cold chiller surfaces subject to condensation which has not been factory insulated.

iv. Piping inside refrigerators and freezers: Provide heat tape under insulation.

3. INSULATION SCHEDULES:

A. Piping

SERVICE	PIPE SIZE	INSULATION TYPE AND THICKNESS
Exterior Chilled Water (including unconditioned spaces and mechanical equipment rooms)	All	2-1/2" Cellular Glass w/ Aluminum Jacket
Interior Chilled Water (Including Domestic)	2" or Less	1-1/2" Cellular Glass w/ ASJ
Interior Chilled Water	2-1/2" or More	2" Cellular Glass w/ ASJ
Refrigerant Suction and Liquid Pipes (except in plenums or fire wall penetrations)	All	1" Elastomeric
Refrigerant Suction and Liquid Pipes (in plenums or fire wall or floor penetrations)	All	1-1/2" Cellular Glass w/ ASJ
Coil Condensate Lines (except in plenums or fire wall penetrations)	All	1/2" Elastomeric
Coil Condensate Lines (in plenums or fire wall or floor penetrations)	All	1-1/2" Cellular Glass w/ ASJ
Heating Hot Water	All	2" Cellular Glass w/ ASJ
Domestic Hot Water, Cold Water, Tempered Water, Recirculated Hot Water, and Service Hot Water	1-1/4" or Less 1-1/2" or More	1-1/2" Mineral Fiber w/ ASJ 2" Mineral Fiber w/ ASJ

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Sanitary Traps, Exposed to Freezing Conditions, and Connected Pipe 10' Downstream	All	1-1/2" Mineral Fiber w. ASJ Raychem XL Self-Regulating Heat Trace
Roof Drain Bodies	All	1-1/2" Mineral Fiber w/ ASJ
Horizontal Rain Water Conductors	All	1-1/2" Mineral Fiber w/ ASJ

B. Ducting

SERVICE	SIZE	INSULATION TYPE AND THICKNESS
Supply, Return and Outdoor Air Ductwork (Interior Concealed)	All	2" Thick Fiberglass Duct Wrap with Tape and Mastic Sealed Seams. R-6.0 Minimum.
Supply, Return and Outdoor Air Ductwork (Exposed to Outdoor Conditions)	All	2" Thick Rigid Ductboard w/ Tented Aluminum Jacket. R-8.0 Minimum.
Supply, Return and Outdoor Air Ductwork (Interior Exposed, Finished Space)	All	Double Wall Duct with 1" Integral Insulation. Paint Grip Exterior Finish.
Supply, Return and Outdoor Air Ductwork (Interior Exposed, Unfinished Space)	All	1.5" Thick Rigid Ductboard Liner w/ FSK facing.
Relief, Exhaust and Transfer Ductwork	All	1" Thick Rigid Ductboard Liner w/ FSK facing. Only Use Where Indicated.
Equipment Operating Under Dewpoint or Subject to Condensation	All	2" Thick Fiberglass Duct Wrap with Tape and Mastic Sealed Seams. R-6.0 Minimum.
Kitchen Grease Exhaust	All	Fire-Wrap to Maintain 2 Hour Rating and Zero Clearance.
Tops of Supply Air Diffusers	All	2" Thick Fiberglass Duct Wrap with Tape and Mastic Sealed Seams. R-6.0 Minimum.

End of Section

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SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.01 DIRECT DIGITAL CONTROL (DDC) SYSTEM DESCRIPTION

- A. Intent. The System Contractor shall supply and install a complete Direct Digital Control (DDC) System as required to accomplish the specified Sequences of Operation for control of heating, ventilating, air-conditioning, and other building equipment and systems as described in this specification.

1.02 SYSTEM REQUIREMENTS

- A. BACnet®. The control system shall consist of a high-speed, peer-to-peer internetwork of ANSI/ASHRAE Standard 135 native BACnet devices. The control system shall also incorporate input/output devices, mechanical/electrical automatic temperature control devices, enclosures, interconnecting conduit, and cabling.
- B. Performance Monitoring. The System shall provide the specified performance monitoring functionality, including required monitoring points and performance metrics, system accuracy, data acquisition and data management capabilities, as well as all required graphical and data displays.
- C. Browser-Based User Interface. The System shall support a Browser-based User Interface (BUI) to the System data. An Operator using a standard web browser shall be able to access the control system graphics and change adjustable setpoints.

1.03 SYSTEM ARCHITECTURE

- A. BACnet internetwork. The System as provided and installed under this specification shall comprise a BACnet internetwork with a multitiered architecture.
 - 1. All communication shall conform to ANSI/ASHRAE Standard 135: BACnet.
- B. Tier 3 Field Level Communication Network (FLCN). This network architecture tier comprises the primary field level infrastructure for the connection of unitary equipment.
 - 1. Tier 3 FLCNs shall be BACnet networks comprised of:
 - a. Unitary BACnet controllers and devices,
 - b. Embedded BACnet equipment controllers, and
 - c. Device-level integration.
 - 2. Tier 3 FLCNs shall use one the following BACnet data links only:
 - a. BACnet/IP: ANSI/ASHRAE Standard 135 Annex J.
 - b. B/VPN: BACnet Virtual Private Network.
 - c. ISO 8802-3 (Ethernet): ANSI/ASHRAE Standard 135.7.
 - d. Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.

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1.04 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Provide, supervise, and coordinate the installation of components supplied under this Section but installed under other divisions of the specification.
- B. Automatic control valves, thermowells, liquid/gas flow switches, liquid/gas flow meters, and energy meters are to be installed by the contractor responsible for the installation of the applicable piping system(s).
- C. Automatic control dampers, airflow measuring stations, and duct-mounted airflow sensors and devices are to be installed by the contractor responsible for the installation of the applicable associated duct and/or mechanical system(s).
- D. Electrical power and energy meters shall be installed by the contractor responsible for the installation of the associated electrical power system.
- E. All line-voltage thermostats and/or System components shall be installed by the contractor responsible for the installation of the associated electrical power system.

1.05 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Low-voltage sensors and components that are integral to the System as specified but supplied under other divisions of the specification shall be installed under this Section.

1.06 RELATED SECTIONS

- A. The General Conditions of the Contract, the Supplementary Conditions, and General Requirements of the project are part of this specification and shall be used in conjunction with this section as part of the Contract Documents.
- B. Submittal Procedures.
- C. Heating, Ventilating, and Air Conditioning (HVAC).
- D. Electrical.

1.07 QUALITY ASSURANCE

- A. The DDC System Manufacturer shall be engaged full-time and shall have been engaged full-time for a minimum of ten (10) years, in the manufacture of equipment and devices of the scope, size, and service consistent with the requirements for this project.
- B. The System Manufacturer shall operate a Quality Management System that is formally certified to be in compliance with ISO 9001:2015.
- C. The System Contractor shall specialize, and have a minimum of ten (10) years of experience in, the design, installation, programming, and operation of Systems consistent with the scope, size, and service specified; and shall:
 - 1. Be an officially authorized representative of the System Manufacturer with an established relationship of not less than ten (10) years.

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2. Assign to the project technicians and engineers who are officially trained and certified by the System Manufacturer in the design, installation, programming, and operation of the System components.
 - a. Upon request, the System Contractor shall present certifications of completed training including hours of instruction and course outlines for all technicians and engineers assigned to, and/or otherwise employed on, the project.
- D. The BACnet internetwork shall be based upon, and installed according to, the System Manufacturer's standard integrated hardware and software product design and in accordance with the System Manufacturer's installation and application documentation.
- E. Acceptable Manufacturer: Reliable Controls Corporation by Enviromatic Systems

1.08 CODES AND STANDARDS

- A. Workmanship, materials and equipment together with the resultant complete and operational System shall be in compliance with the Authorities Having Jurisdiction (AHJ) for the project and the most restrictive of applicable local, state, and federal codes and ordinances in cooperation with these plans and specifications. At a minimum, the installation shall comply with the current editions in effect thirty (30) days prior to receipt of bids of the following applicable codes:
 1. ANSI/ASHRAE Standard 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks.
 2. National Electric Code (NEC).
 3. International Building Code (IBC).
 4. International Mechanical Code (IMC).
 5. Underwriters Laboratories (UL).
 - a. UL-916 – Energy Management Systems (EMS).
 - b. UL-864/UUKL – Control Units and Accessories for Fire Alarm Systems.

1.09 SYSTEM PERFORMANCE

- A. Performance Standards. The System shall conform to the following minimum performance standards using the project-deployed, normal-service, production hardware, firmware, software, and network connections:
 1. Graphic Display. A minimum of 50 dynamic real-time data points shall be displayed within 10 seconds of the request and shall refresh with current data within 5 seconds.
 2. Operator Command. The maximum time between the command of a binary or analog object by the operator and the reaction initialization by the device shall be 2 seconds.
 3. Object Command. Devices shall respond to automatic command of a binary or analog object within 2 seconds.

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4. Object scan. Changes of state or analog values shall be transmitted such that reporting of a value is never more than 15 seconds old and is reported within 15 seconds of a change in value.
 5. Alarm Response. The maximum amount of time from when an object goes into alarm until it is annunciated at the workstation shall not exceed 20 seconds.
 - a. Each workstation on the network shall receive alarms within 5 seconds of other workstations.
 6. Program Execution. All programs in all DDC devices shall be able to execute at a minimum of at least one time every second. Program execution time shall be configurable to be consistent with the process under control.
 7. Control Loop Performance. All DDC devices shall be able to execute control loops at a frequency at least one time every second. The controller shall update the process value and output generated by this calculation at this same frequency at a minimum or as appropriate for the mechanical process under control.
- B. Environmental Conditions. All System components provided under this specification shall operate under ambient environmental conditions of -20°C (-4°F) to 55°C (131°F) dry-bulb and 10% to 90% relative humidity, non-condensing at a minimum. Sensors and control elements shall be constructed of materials suitable and rated for the media sensed under the ambient environmental temperature, pressure, humidity, and vibration conditions typical for the installed location.
- C. Power Conditions. Networked components of the System shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.
- D. Reporting Accuracy. System shall report values with minimum end-to-end accuracy as listed in Table 1 through Table 5.
- E. Control Stability and Accuracy. Control applications shall maintain process variables at setpoint within the tolerances listed in Table 1 through Table 5.
1. Combined system repeatability of sensors, controllers, and readout devices for a particular application shall be $\pm 2\%$ of full scale of the operating range.
 2. Repeatability of overall combined system of sensor, controller, and readout device in a control loop application will be $\pm 5\%$ of full scale of the operating range.
 3. Long-term electronic drift shall not exceed 0.4% per year.

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TABLE 1: SENSOR, METER, & VALUE REQUIRED ACCURACIES

SENSOR		SENSOR DETAILS		REQ UI RED END - T C - E N D A C C U R A C Y	DISP L A Y F E S C L U T I C N			
Outdoor Ambient dry-bulb tempera ture.	AI	10K-ohm, NTC, thermistor. Locate in weather station or ventilated enclosure in fully shaded location away from thermal mass bodies.	$\pm 0.2^{\circ}\text{C}$ ($\pm 0.36^{\circ}\text{F}$)	0.1°C (0.18°F)	1	10	$\pm 1.0^{\circ}\text{C}$ ($\pm 2.0^{\circ}\text{F}$)	
Outdoor Ambient wet-bulb	AI	Locate in weather station or ventilated enclosure in fully	$\pm 0.3^{\circ}\text{C}$ ($\pm 0.54^{\circ}\text{F}$)	0.1°C (0.18°F)	1	10	$\pm 1.5^{\circ}\text{C}$ ($\pm 3.0^{\circ}\text{F}$)	

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	tempera ture.	shaded location away from thermal mass bodies.						
Space temperature	AI	10K-ohm, NTC, thermistor.	±0.3°C (±0.54°F)	0.1°C (0.18°F)	1	10	±0.5°C (±1.0°F)	
Carbon dioxide (CO ₂)	AI	Nondispersive infrared sensor.	±30 ppm to ±5% of reading	50 ppm	1	1	40 ppm	
Air pressure (duct)	AI		±25 Pa (±0.1 inwc)	125 Pa (0.5 inwc)	1	1	25 Pa (0.1 inwc)	
DX Coil EAT / LAT	AI	10K-ohm, NTC, thermistor.	±0.5°C (±1.0°F)	0.1°C (0.18°F)	1	1	±1.5°C (±3.0°F)	
HW Coil EAT / LAT	AI	10K-ohm, NTC, thermistor.	±0.5°C (±1.0°F)	0.1°C (0.18°F)	1	1	±1.5°C (±3.0°F)	
Space Relative Humidity (RH)	AI		±5% RH	5%	1	1	±5% RH	

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AHU supply fan power	AI/ BI	True RMS, three-phase, integrated equipment, stand-alone analog or pulse output or network meter; use maximum resolution if pulse output.	±1.5% of reading; ±3%VFD reading	0.1 kW	1	1	0.001 kW
AHU discharge air temperature	AI	10K-ohm, NTC, thermistor.	±0.2°C (±0.36°F)	0.1°C (0.18°F)	1	10	±0.5°C (±1.0°F)
AHU mixed air temperature	AI	10K-ohm, NTC, thermistor. Use averaging sensor located in AHU mixed air section installed in a serpentine manner vertically across the duct.	±0.2°C (±0.36°F)	0.1°C (0.18°F)	1	10	±0.5°C (±1.0°F)
AHU return air temperature	AI	10K-ohm, NTC, thermistor. Locate upstream of AHU return air damper.	±0.2°C (±0.36°F)	0.1°C (0.18°F)	1	10	±0.5°C (±1.0°F)
AHU outdoor air damper position	AO		N/A	0.1%	1	10	0.1%
AHU return air damper position	AO		N/A	0.1%	1	10	0.1%
AHU percentage outdoor air	AV	Instantaneous difference of measured values (S35- S36)/(S1-S36).	N/A	0.1%	1	1	0.1%

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1.10 SUBMITTALS

- A. Submittals must be prepared and submitted in compliance with all General Conditions of the Contract, Supplementary Conditions, and General Requirements of the project and in conjunction with the requirements of this section.
- B. No work may begin on any segment of this project until submittals have been successfully reviewed and approved for conformity with the design intent.
- C. All submittals and documentation including complete System engineering design submittal & drawings, project record documents, application engineering documents, and Operation & Maintenance manuals shall be submitted electronically in the form of an ISO 32000 Portable Document Format (PDF).
 1. All control schematics, wiring diagrams, riser diagrams, etc. shall be formatted for ANSI B (279 mm x 432 mm; 11" x 17") or A3 paper size (297 mm x 420 mm).
 2. All other documentation may be formatted for ANSI A (216 mm x 279 mm; 8.5" x 11") or A4 (210 mm x 297 mm).
- D. Submit in writing and so delineated at the beginning of each submittal, known conflicts, substitutions, and deviations from requirements of Contract Documents. Deviation from Contract Documents must be approved by Owner and/or Contracting Officer prior to award of contract.
- E. Each submitted piece of literature and drawing shall clearly reference the applicable specification section and/or drawing that the submittal responds to.
 1. General catalogue sheets shall not be acceptable as cut sheets.
- F. Submittal documentation and drawings shall consistently use the same abbreviations, symbols, nomenclature, and identifiers. Each control system element shall be assigned a unique identifier pursuant with the Contract Documents.
- G. Submittal documentation and drawings shall have at the beginning an index and design drawing legend.
 1. Index shall list all design drawings and elements including the drawing number, sheet number, drawing title, etc.
 2. Legend shall show and describe all symbols, abbreviations, and acronyms used on the design drawings.
- H. System Hardware Submittals. Submit the following at a minimum:
 1. A complete Bill of Materials of all equipment, controllers, devices, and sensors to be provided and/or used indicating unique equipment identifier, unique device identifier, manufacturer, model number, and quantity.
 2. A Protocol Implementation Conformance Statement (PICS) including a BACnet Interoperability Building Block (BIBB) table for each DDC device included in the submittal.

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3. Manufacturer's technical data including product specification sheets, performance curves, and installation/maintenance instructions. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly called out by other means.
 4. Schematic diagrams for all field sensors and controllers providing floor plans indicating the locations of all sensors, devices, and temperature control panels.
 5. Control enclosure details for each enclosure including panel identifier, location, physical lay-out, dimensions, instrumentation, labels, etc.
 6. Wiring diagrams and schematics for each control enclosure showing power source for each panel, secondary power, and network termination as well as all individual terminations, terminal numbers, point type, and mnemonic/name.
 7. Wiring diagrams for all packaged equipment, motor starters, relay wiring, equipment interlock, safety circuits, etc. clearly indicating all interconnecting wiring and termination of all conductors and cables including labels of all cables and point mnemonics.
 8. Wiring diagrams and schematics for each sensor.
- I. Controlled System Submittals.
1. Riser diagram showing the physical lay-out of the entire internetwork.
 2. Riser diagram for each individual BACnet network including the ELCN, and each BLCN and FLCN including:
 - a. Data link with physical characteristics and configuration.
 - b. Each BACnet networked DDC device including location, service, device instance, MAC address, and network number.
 - c. Each IP networking device including location, service, and IP address.
 - d. Location of all interface devices including network interface jacks and workstation connections.
 - e. Location of all MS/TP network termination points and End-of-Line (EOL) terminations.
 3. A schematic control flow diagram of each controlled system showing actual physical configuration and location of all control elements including each hardware point type, controller, and mnemonic.
 4. A schematic wiring diagram of each controlled system showing actual physical wiring and termination of all control elements including each hardware point type, controller, mnemonic, and terminal number.
 5. An instrumentation list for each controlled system displaying each control element, name, manufacturer, model, and product data sheet number in a tabular format.

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6. A complete description of the operation of the System including a specific Sequence of Operation for each controlled system. Sequences of Operation shall:
 - a. Reference the submitted schematic of the controlled system.
 - b. Refer to equipment and control devices by their specific unique identifiers pursuant with the Contract Documents and the System submittal package.
 - c. Clearly represent actual application programming methodology and functional control operation not merely a copy of the Contract Document specified sequence of control.
 - d. Include a concise description of functional system operation under specified normal and failure conditions.
 - e. Include a complete hardware input and output (I/O) points schedule identifying for each point its instance, type, name/mnemonic, controller, equipment/function, location, termination, override, alarm, and display criteria.
7. Operational deviation from the specified Sequences of Operation as outlined in Contract Documents shall not be permitted under any circumstances without prior written approval by the Owner, Engineer, or Contracting Officer.
8. A schedule of all control valves. This shall include the unique equipment identifier, valve size, dimensions and installation/maintenance clearance, model number (including pattern and connections), close-off rating, flow, CV, pressure drop, pressure rating, and location. The valve schedule shall also contain actuator selection data supported by calculations of the force required to move, close, and seal the valve at design conditions.
9. A schedule of all control dampers. This shall include the unique equipment identifier, unique damper identifier, damper size, pressure drop, blade configuration, orientation and axis of frame, blade rotation, location and selection criteria of actuators, nominal and actual sizes, manufacturer, and model number. The Damper Schedule shall include the AMCA 500-D maximum leakage rate at the operating static-pressure differential.

J. Schedules.

1. Provide a schedule of work indicating at a minimum the intended sequence of work, start dates and durations for individual activities, delivery dates for major materials and equipment including anticipated lead times, and milestones indicating possible restraints on work by other trades or construction delays.

K. Project Record Documentation.

1. Upon completion of installation and System commissioning activities submit record (as-built) documents for review to include:
 - a. Testing and commissioning reports and checklists.

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- b. Operation and Maintenance (O&M) manuals.
- c. As-built revisions of all submittal data updated to reflect actual field conditions, architecture and execution.
- d. Names and 24-hour contact information for installing contractors and service representatives.
- e. Operator's manual with administrator and operator level credentials and procedures for operating the System including logging-on/off, handling alarms, generating points reports, trending data, overriding automatic control, changing setpoints, and control variables.
- f. Programming manual describing the programming language structure and syntax.
- g. Engineering manual describing database management and modification.
- h. Installation and maintenance manuals describing how to install and configure new hardware as well as how to perform routine preventative maintenance and calibration together with corrective diagnostic troubleshooting procedures.
- i. Documentation of all programs created including setpoints, tuning parameters, and final database.
- j. Complete system database as functional after system commissioning and functional testing including all graphics and images used by and/or created for System on electronic format as accepted by the Owner.
- k. Final Bill of Material with all installed parts, manufacturers, manufacturers' part numbers, and ordering information.
- l. A schedule of recommended spare parts with part numbers and supplier.
- m. All original-issue installation and maintenance manuals, user guides, and other documentation provided with all hardware and software provided as a part of this specification.
- n. Licenses, guarantees, and warrantee documentation for all equipment and systems.

1.11 WARRANTY

- A. The System Manufacturer shall warranty all DDC controllers to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit's performance specifications for a period of five (5) years at a minimum.
 - 1. Sensors and field components integral to DDC controllers shall be warrantied to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit's performance specifications for a period of one (1) years at a minimum.

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- B. The System Contractor shall warranty the installation of all other DDC materials and labor to be free of defects under normal expected service and use for a period of one (1) year from the date of final acceptance.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Upon project acceptance all software and documentation delivered as a part of this specification shall become the exclusive property of the Owner; including but not limited to: all graphics, record drawings, database, application programming code, and documentation.

END OF PART 1

PART 2 - PRODUCTS

2.01 PRODUCT REQUIREMENTS

- A. The System as provided and installed under this specification shall be comprised of BACnet devices including controllers, routers and sensors as necessary to accomplish control of the equipment with complete interoperability with the existing BACnet building control system.
 - 1. The entirety of the System Manufacturer product line selected shall be designed and deployed specifically with standard provisions for integral backwards compatibility and extensibility.
 - a. System Manufacturer shall certify that System devices, and spare or equivalent components shall be readily available for a minimum of five (5) years after the completion and final acceptance of this project.
 - 2. OEM and/or private-labelled controllers or software manufactured or developed by a third-party and labelled or otherwise represented as being a product of the System Manufacturer shall not be accepted under this specification.
 - 3. Non-networked system components specified in this section (including sensors, valves, dampers, etc.) need not be manufactured by the System Manufacturer.

2.02 COMMUNICATION

- A. BACnet. The System as provided and installed under this specification shall comprise a BACnet internetwork and provide complete inter-operability with the existing BACnet system installed. Devices that require translation of data, gateways, or mapping of any kind for communication between System devices shall not be acceptable.

2.03 CONTROLLERS

- A. Environment. All controllers shall be suitable for permanent installation in conditioned spaces and shall be rated for operation at -20°C to 55°C (-4°F to 131°F).
 - 1. All controllers shall be suitable for permanent installation in the design location and ambient conditions.
 - 2. Controllers shall not be installed outdoors or in wet conditions.

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- B. Power & Noise. All controllers shall be able to operate at 90% to 110% of the nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
 - 1. Controllers shall be certified in compliance with FCC/ICES-003 CFR47 Part 15/B.
- C. Serviceability. All controllers shall be provided with diagnostic LEDs to indicate power, communication, and processor status.
- D. Memory. All controllers shall have sufficient memory to support the operating system, database, and programming necessary to satisfy the specified Sequence of Operation and to comply with the requirements of all applicable System specifications.
 - 1. Battery/capacitor shall maintain runtime values and clock memory following a loss of power for a minimum of 72 hours.
 - 2. The database and programming shall be maintained without power for a minimum of 10 years.
 - 3. All application programs shall be stored on individual controllers in non-volatile memory.
- E. Communication Port. Each individual DDC controller shall provide a communication port for the connection of an operator workstation.
- F. Universal Inputs. All physical inputs on all controllers shall support at a minimum the following physical characteristics:
 - 1. Thermistor.
 - 2. Dry-contact.
 - 3. Current (4-20 mA).
 - 4. Voltage (0-10 VDC).
 - 5. 150 Hz pulse counting.
 - 6. 12-bit A/D resolution.
 - 7. 24 VAC over-voltage protection.
- G. Outputs. Physical outputs on all controllers shall support at a minimum the following physical characteristics:
 - 1. Universal (0-12 VDC; 75 mA @ 12 VDC).
 - 2. 12-bit D/A resolution.
 - 3. 24 VAC over-voltage and short protection.
- H. Database. All controller programming, configuration, and modification shall be accomplished via the internetwork from the B-AWS. The complete operational database and application program shall reside in each individual controller.

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1. Each controller shall provide microprocessor-based, self-contained, stand-alone, fully-programmable operation of local process control loops.
 2. All controllers shall function in a real-time, multitasking, networked operating environment; able to display database values, programs, and control loops in real-time while functional and simultaneously available to the operator online from the B-AWS, B-OWS, or B-OD.
- I. Programmability. All controllers shall be freely-programmable and support custom control strategies, programs, and databases that are completely modifiable over the BACnet internetwork once installed.
1. All controllers delivered as a part of this specification shall be programmed using one (1) common programming language, means, and method via the B-AWS or enterprise B-OWS. Devices that require separate custom applications for programming shall not be acceptable.
 2. Application specific and/or configurable devices are strictly prohibited.
- J. Schedules. All controllers shall support the standard BACnet Schedule and BACnet Calendar objects.
1. Schedule objects shall reside in each individual device.
 2. Applications requiring schedule objects and/or parameters to be stored exclusively on a workstation or server shall be strictly prohibited.
 3. All controllers shall support binary, analog, and multi-state BACnet Schedule objects.
- K. Trend Logs. All controllers shall locally perform and manage historical data collection.
1. All controllers shall support:
 - a. The BACnet Trend Log object.
 - b. The BACnet Trend Log Multiple object.
 - c. Change Of Value (COV) trending.
 2. All trend log data shall be stored in non-volatile memory and be preserved through loss of power.
 3. All objects (both hardware and software) system-wide shall be assignable to user-definable trend logs with configurable sample rates and length.
 4. Trend log data shall be stored at each individual controller, and uploaded to hard disk storage by a BTL-Listed BACnet device dedicated for this service when long-term archiving is required.
- L. Runtime Logs. All controllers shall support logging and reporting of runtime for every binary object in the system.

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1. Runtime data shall be sampled and stored in each individual BACnet device using standard BACnet objects and published properties. A workstation shall not be required for storage of custom runtime logs.
- M. Operator Displays. All controllers featuring an operator display shall be aesthetically pleasing and specifically designed for permanent installation in a finished, occupied space.
- N. Communicating Sensors. All controllers, except as expressly permitted below, shall support and be capable of monitoring and controlling a network of communicating sensors without consuming physical hardware input/output points on the device.
 1. A minimum of four (4) communicating sensors shall be supported by each DDC controller.
 2. Space mounted terminal unit controllers with fewer than four (4) inputs and four (4) outputs shall not be required to support communicating space sensors.
- O. Alarm Annunciation. All IP-enabled controllers shall support Simple Mail Transfer Protocol (SMTP) and provide stand-alone remote annunciation of alarms via e-mail without additional hardware or software.

2.04 FIELD-LEVEL EQUIPMENT CONTROLLERS

- A. Field-level equipment controllers shall be provided in compliance with the requirements for Controllers and as required to achieve the performance prescribed in this specification as designated.
 1. Field-level equipment controllers are responsible for control of individual equipment that comprises mechanical systems.
 2. Field-level equipment controllers are responsible for control of individual equipment that executes indoor environmental quality control and monitoring strategies.
 3. Field-level equipment controllers are responsible for the execution of global and local strategies, and local device integration.
- B. BACnet Device Profile. Field-level equipment controllers shall be certified and Listed by the BACnet Testing Laboratories (BTL) in compliance with the minimum requirements of ANSI/ASHRAE Standard 135-2012 Revision 14 Annex L a minimum of 30 days prior to the bid date for this project as follows:
 1. BACnet Building Controller (B-BC).
- C. BACnet Networking. Field-level equipment controllers shall natively support the following BACnet data links as specified in ANSI/ASHRAE Standard 135 and in compliance with the following physical layer standards at a minimum:
 1. BACnet/IP: ANSI/ASHRAE Standard 135 Annex J.
 - a. ISO 8802.3 Ethernet (10/100 BaseT),
 - b. ISO 8802.3af PoE (10/100 BaseT), or

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- c. ISO 8802.11b/g/n Wi-Fi.
- 2. ISO 8802-3 (Ethernet): ANSI/ASHRAE Standard 135.7.
 - a. ISO 8802.3 Ethernet (10/100 BaseT),
 - b. ISO 8802.3af PoE (10/100 BaseT).
- 3. Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.
 - a. TIA-485.
- D. Power & Noise. In addition to the power and noise requirements for all controllers, field-level equipment controllers shall also support the following physical power link:
 - 1. ISO 8802.3af PoE.
- E. Universal Inputs. Field-level equipment controllers shall be provided with a minimum of six (6) software-selectable universal inputs dedicated for the connection of field devices compliant with the requirements for all controllers.
- F. Integral Sensors. In addition to universal inputs dedicated for the connection of field devices, field-level equipment controllers shall support the following integral sensors at a minimum:
 - 1. Temperature.
 - a. Resolution: ± 0.1 °C (0.18 °F).
 - b. Accuracy: ± 0.1 °C (0.18 °F).
 - 2. Relative Humidity.
 - a. Range: 10-90 %RH.
 - b. Resolution: ± 0.1 %RH.
 - c. Accuracy: ± 3 %RH.
 - 3. CO₂.
 - a. Range: 400-2000 ppm.
 - b. Accuracy: ± 35 ppm.
 - c. Non-Linearity: < 1% of full scale.
 - d. Technology: Non-Dispersive Infrared Optical Sensor.
 - 4. Occupancy.
 - a. Range: 5 m (16.4').
 - b. Angle: 100° horizontal/82° vertical.
 - c. Technology: Passive Infrared Radiation (PIR).
 - 5. All integral sensors shall comply with the System performance criteria detailed elsewhere in this specification.

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- G. Outputs. Field-level equipment controllers shall be provided with a minimum of six (6) jumper-selectable physical outputs dedicated for the connection of field devices. In addition to the requirements for universal outputs on all controllers, building-level equipment controllers shall also support at a minimum the following physical characteristics:
 - 1. Solid state relay (500 mA @ 24 VAC/VDC).
 - a. The act of switching must not produce an audible noise discernable to the occupants of the space where the device is installed.

2.05 FIELD-LEVEL OPERATOR DISPLAY

- A. Field-level operator displays shall be provided in compliance with the requirements for Controllers and as required to achieve the performance prescribed in this specification as designated.
 - 1. Field-level operator displays complement field-level equipment controllers with a comprehensive local interface for the System.
 - 2. Field-level operator displays shall be required to comply with all the requirements for field-level equipment controllers in addition to those prescribed in this specification clause.
- B. BACnet. All field-level operator displays shall be certified and Listed by the BACnet Testing Laboratories (BTL) in compliance with the minimum requirements of ANSI/ASHRAE Standard 135-2012 Revision 14 Annex L prior to the bid date for this project as follows:
 - 1. BACnet Building Controller (B-BC), and
 - 2. BACnet Operator Display (B-OD).
- C. Integral Operator Display. Each field-level operator display shall comply with the following minimum criteria:
 - 1. Full-color Wide Quarter VGA (WQVGA) Display.
 - 2. Thin Film Transistor (TFT) Projective Capacitive Touch (PCAP) interface.

2.06 COMMUNICATING SPACE SENSORS

- A. Networked, communicating space sensors shall be supported by DDC controllers as required in this specification for monitoring indoor environmental conditions and provision of low-level operator interface without consumption of hardware inputs/outputs on the host controller.
 - 1. Communicating space sensors shall be aesthetically pleasing and specifically designed for permanent installation in a finished, occupied space.
 - 2. Communicating space sensors shall be developed, manufactured, and supported by the System Manufacturer and shall be provided by the System Contractor.

2.07 COMMUNICATING DUCT SENSORS

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- A. Networked, communicating duct sensors shall be supported by DDC controllers as required in this specification without consumption of hardware inputs/outputs on the host controller.
 - 1. Communicating duct sensors shall be developed, manufactured, and supported by the System Manufacturer and shall be provided by the System Contractor.

2.08 AUTOMATIC CONTROL DAMPERS

- A. Automatic Control Dampers. All automatic control dampers provided as a part of this specification shall bear the AMCA seal in compliance with the AMCA Certified Ratings Program(s).
- B. Opposed Blade Style. Unless otherwise scheduled on the contract drawings, opposed blade dampers shall comply with the following:
 - 1. Opposed blade dampers shall be used for all mixing, volume throttling, and discrete airflow control applications installed in outdoor, relief, exhaust, and/or supply air streams as well as all applications immediately upstream of critical equipment and all ducted outlets.
 - 2. Blade edges shall be interlocked and blade seals shall be compressible at all contact points. Channel frames shall be provided with jamb seals.
- C. Parallel Blade Style. Unless otherwise scheduled on the contract drawings, parallel blade dampers shall comply with the following:
 - 1. Parallel blade dampers shall be used in two-position, mechanical ventilation and exhaust, combustion intake and exhaust applications, as well as applications where the damper constitutes the primary source of total system pressure loss or where greater control is required at the upper end of the airstream volume operating range.
 - 2. Parallel blade dampers may also be used for outdoor and return air mixing applications as scheduled and if arranged to direct the airstreams toward one another.
- D. Sections. Individual damper sections shall not exceed 1.25 m (48") wide and 1.5 m (60") tall. Applications requiring larger dampers shall be achieved by combining single damper sections. One (1) actuator, at a minimum, shall be provided per section.
- E. Frame. Damper frame construction shall be a minimum of 13-gauge galvanized steel channel or 3 mm (1/8") extruded aluminum with reinforced corner bracing and continuously welded.
- F. Blades. Damper blades shall not exceed 20 cm (8") in width or 125 cm (48") in length. Blades are required to be suitable for medium velocity performance of 10 m/s (2000 fpm) at a minimum.
 - 1. Damper blades and baffles shall be fabricated of minimum 16-gauge steel with corrosion resistant galvanized finish or 2 mm (0.08") extruded aluminum at 15 cm (6") width.

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2. Damper blades mounted vertically shall be supported by thrust bearings
 3. Dampers shall have a minimum of four brakes running the entire length.
- G. Seals. All damper blade edges as well as the top and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. Blade seals shall provide for a maximum leakage rate of 50 L/s per m² (10 cfm per ft²) at 1000 Pa (4 inwc) differential pressure. Provide air foil blades suitable for a wide-open face velocity of 7.5 m/s (1500 fpm).
1. Damper leakage shall be certified in accordance with AMCA Standard 500-D.
- H. Bearings. Damper shaft bearings shall be as recommended by the manufacturer for the specific application; nylon, cyclopol, oilite® style oil impregnated sintered bronze or better.
- I. Shafts. Shafts shall be a minimum of 12 mm (1/2") diameter and be welded or riveted to the blade.
- J. Outdoor Suitability. All outdoor air damper components shall be suitable for applications operating in the temperature range of -40°C (-40°F) to 75°C (167°F).
- K. Linear Characterization. All automatic control dampers in modulating applications shall be sized to achieve linear airflow characteristics.
- L. Operating Linkages and Damper Accessories:
1. All operating linkages and/or damper accessories required for installation and application in accordance with specification design intent and manufacturer's installation procedures shall be provided.
 2. Operating linkages provided external to dampers (e.g., crank arms, connecting rods, shaft extensions, etc.) for transmitting motion from the actuator/operator to dampers shall be designed as to functionally operate a load equal to or exceeding 300% of the maximum required operating force for the damper.
 3. Crank arms and connecting rods shall be adjustable. Linkages shall be brass, bronze, zinc-coated steel, or stainless steel.
 4. Adjustments of crank arms shall control the position of the damper.
 5. Use of operating linkages external to damper drive shaft shall neither delay nor impede operation of the damper in a manner of performance less than a direct-coupled damper actuator. Operating linkages shall not under any circumstances be permitted to flex, warp, shift etc. under normal operation of connected damper sections.

2.09 AUTOMATIC CONTROL VALVES

- A. Automatic Control Valves. Control valves shall be two-way or three-way type for two-position or modulating service as required and/or scheduled. Unless otherwise indicated, all valves shall have a minimum rangeability of 50:1.

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- B. Body & Trim. Body and trim style and materials shall be in accordance with the manufacturer's recommendations for design conditions and service shown in compliance with the following at a minimum:
 - 1. Equal percentage ports for modulating service.
 - 2. Valve bodies shall meet or exceed pressure and temperature class rating based upon design operating temperature and 150% design operating pressure. Unless otherwise specified or scheduled, minimum body rating for any valve is 860 kPa (125 psi) and a maximum fluid temperature of 177°C (350°F).
 - 3. Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation.
 - 4. Globe valves shall have replaceable seats.
- C. Close-Off/Differential Pressure Rating. All valves shall be guaranteed to have not more than 1% leakage of design flow rate at the pump shut-off pressure. All valve actuators and trim shall be furnished to provide the following minimum close-off pressure ratings unless otherwise specified or scheduled:
 - 1. Two-way water valves: 150% of total system (pump) head.
 - 2. Three-way water valves: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head (whichever is greater).
 - 3. Steam valves: 150% of operating (inlet) pressure.
- D. Water Valves. Unless otherwise specified or scheduled, water valves shall follow the following criteria:
 - 1. Two-position service: Line size.
 - 2. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through the heat exchanger (coil, load, etc.), 50% of the pressure difference between the supply and return mains, or 35 kPa (5 psi) (whichever is greater).
 - 3. Three-way modulating service: Pressure drop shall be equal to twice the pressure drop through the heat exchanger (coil, load, etc.), 35 kPa (5 psi) maximum.
 - 4. Valves DN 15 (1/2") through DN 50 (2") shall be bronze or cast brass body, ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless-steel ball.
 - 5. Valves larger than DN 65 (2 1/2") and larger shall be cast iron, ANSI Class 125, with guided plug and PTFE packing.
 - 6. Valves DN 15 (1/2") through DN 50 (2") shall be ANSI/ASME B1.20.1 (NPT) threaded connections.
 - 7. Valves DN 65 (2 1/2") and larger shall use flanged connections.

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8. Water valves shall fail normally open or closed, as scheduled on plans, or as follows:
 - a. Water zone valves: normally open.
 - b. Heating coils in air handlers: normally open.
 - c. Chilled-water control valves: normally closed.
- E. Control Ball Valves. Where scheduled, control ball valves shall comply with the following:
 1. All control ball valves shall be furnished with chrome plated bronze ball and stainless-steel stem with fiberglass reinforced Teflon® seats and seals. The valves shall have a blowout proof stem design.
 2. The stem packing shall be 2 O-rings designed for modulating service and requiring no maintenance.
 3. All control ball valves shall feature characterized flow guides when used for modulating applications.

2.10 AUTOMATIC CONTROL ACTUATORS

- A. Electric Actuation. Unless otherwise specified or scheduled, all control actuators shall be electric/electronic direct-coupled type.
 1. Actuators shall have a means for reversing drive direction and a manual override accessible at the front cover.
 2. The actuator shall have electronic overload or stall protection to prevent damage to the actuator throughout rotation. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
 3. Spring Return. Where shown, for power-failure or safety applications, an internal mechanical spring-return mechanism shall be built-in to the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
 - a. All mechanical equipment with direct introduction of outside air shall require fail-safe spring return actuators.
 - b. Terminal equipment without direct introduction of outside air are permitted to have actuators that maintain their last commanded position when power is lost to the actuator.
 4. Clutch/Gear Release. All non-spring return actuators shall have an external manual clutch/gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 7 Nm (60 in-LB) torque capacity shall have a manual crank for this purpose.
 5. Modulating Actuators. Unless otherwise specified or scheduled, all modulating actuators shall be positive positioning and accept a 0-10 VDC or 0-20 mA control signal and provide an operating range of 2-10 VDC or 4-20 mA.

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6. Position Feedback. All actuators shall feature a visual position feedback indicator. All non-terminal unit actuators shall provide a 2-10 VDC or 4-20 mA feedback signal.
 7. Power. All 24 VAC/VDC actuators shall operate on Class 2 circuits.
 8. Enclosure. Actuator casing and/or enclosures shall be appropriate to the application.
 - a. Actuators used in or near outdoor air streams shall have IEC IP21 (NEMA 2) housings.
 - b. Actuators exposed to moisture, in wet mechanical rooms, or located outdoors shall be meet IEC IP66 (NEMA 4X) requirements or as directed by the AHJ.
- B. Where expressly specified or scheduled to be used, pneumatic damper/valve actuators and positioners shall comply with the following minimum requirements:
1. Pneumatic actuators shall be piston-rolling diaphragm type or diaphragm type with easily replaceable, beaded, molded neoprene diaphragm.
 2. Actuator housings may be molded or diecast zinc or aluminum.
 - a. Exception: Actuator housings for terminal unit zone control dampers or valves may be of high-impact plastic construction with an ambient temperature rating of 10-60°C (50-140°F) minimum. However, any plastic devices located in return air (ceiling) plenums shall be isolated from plenums with an auxiliary metal enclosure having a quick-opening access panel.
 3. Actuator size and spring ranges selected shall be suitable for intended application.
 4. Rate pneumatic actuators for a minimum 140 kPa (20 psig).
 5. Damper actuators shall be selected in accordance with manufacturer's recommendations to provide sufficient close-off force to effectively seal damper and to provide smooth modulating control under design flow and pressure conditions.
 - a. Furnish a separate actuator for each damper section.
 6. Valve actuators shall provide tight close-off at design system pressure and shall provide smooth modulation at design flow and pressure conditions.
 7. On sequencing applications, valve and damper actuators shall be sized for a maximum of 14 kPa (2 psi) shift in nominal spring range. Spring ranges shall be selected to prevent overlap or positive positioners shall be provided.
 8. Positive positioners to have the following performance characteristics:
 - a. Linearity: $\pm 10\%$ of output signal span.
 - b. Hysteresis: 3% of the span.

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- c. Response: 1.75 kPa (1/4 psi) input change.
 - d. Maximum pilot signal pressure: 140 kPa (20 psi).
 - e. Maximum control air supply pressure: 420 kPa (60 psi).
9. Positive positioners shall be provided on actuators for inlet vane control and on any other actuators where required to provide smooth modulation or proper sequencing.
- a. Positive positioners shall be high-capacity force balance relay type with suitable mounting provisions and position feedback linkage tailored for each actuator.
 - b. Positive positioners shall use full control air pressure at any point in stem travel to initiate stem movement or to maintain stem position. Positioners shall operate on a 20-100 kPa (3-15 psi) input signal unless otherwise required to satisfy the control sequences of operation.

2.11 TEMPERATURE DEVICES

- A. Analog Temperature Sensors. Analog temperature sensors shall be precision element thermistor type.
- B. Duct Sensors. Duct temperature sensors shall include junction box for wiring connections and gasket to prevent air leakage and vibration noise.
 - 1. Single point duct temperature sensor probe shall consist of 316 stainless steel extending to the center of the duct.
 - 2. Averaging duct temperature sensor shall consist of a copper or stainless-steel averaging element. Averaging sensors shall be a minimum of 1.5 m (5') in length per 1 m² (10 ft²) of duct cross sectional area.
 - 3. Immersion Sensors. Liquid immersion temperature sensor shall be provided with a separable stainless steel well. The well must be designed to be consistent and appropriate with the system operating pressure and velocity.
 - 4. Space Sensors. Space temperature sensor shall consist of an element within a ventilated cover aesthetically pleasing and specifically designed for permanent installation in a finished, occupied space.
 - a. In private and semi-private spaces that serve full-time or full-time-equivalent occupants including but not limited to offices, work rooms, meeting rooms, conference rooms, etc., space sensors shall be provided with setpoint adjustment and occupancy bypass. Bypass not required in zones with occupancy sensors or applications that are constantly occupied.
 - b. In public spaces without full-time or full-time-equivalent occupants including but not limited to lobbies, hallways, atriums, break rooms, cafeterias, restrooms, theaters, gymnasiums, mechanical spaces, plenums, etc., simple temperature sensor without setpoint or bypass shall be provided.

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- c. Sensors with operator interface keypads and displays shall be provided as indicated or scheduled elsewhere.
- 5. Outdoor Air Temperature. Outdoor air temperature sensor shall consist of a single device sensor, ventilated non-metallic sun shield, utility box for terminations, and watertight gasket to prevent water seepage.
- 6. Differential Temperature. Provide matched sensors for differential temperature applications.
- 7. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL-Listed, vapor pressure type, with an element of 6 m (20') minimum length.
 - a. Provide one (1) low-limit thermostat for each 2 m² (20 ft²) of coil face.
 - b. Low-limit thermostat shall respond to the lowest temperature sensed in by any 30 cm (12") section of the element.
 - c. Low-limit thermostats shall be manual-reset, DPDT-style with a minimum of one (1) normally-open contact and one (1) normally-closed contact.
- 8. High-Limit Thermostats. High-limit airstream thermostats shall be UL-Listed, bimetal-operated, manual reset type.
- 9. Low-voltage Thermostats. Low-voltage thermostats shall be 24 VAC, bimetal-operated or electronic type with adjustable fixed anticipation heater, concealed setpoint adjustment 13-30°C (55-85°F) setpoint range, 1°C (2°F) maximum differential and vented ABS plastic housing.
- 10. Line-voltage Thermostat. Line-voltage thermostats shall be UL-Listed bi-metal actuated, open contact type, enclosed, snap-switch type or equivalent solid-state type with adjustable of fixed anticipation heater, concealed setpoint adjustment 13-30°C (55-85°F) range, 1°C (2°F) maximum differential, and vented ABS plastic housing.

2.12 HUMIDITY DEVICES

- A. Duct Sensors. Duct-mounted humidity sensors shall have a sensing range of 20% to 80% RH and shall be provided with a sampling chamber.
- B. Space Sensors. Space sensors shall have a sensing range of 20 to 90% RH.
- C. Outdoor Air Sensors. Outdoor air humidity sensors shall have a sensing range of 20 to 95% RH and shall be suitable for ambient conditions of -40°C to 75°C (-40°F to 170°F).
- D. Drift. Sensor drift shall not exceed 1% of full scale per year.

2.13 PRESSURE TRANSDUCERS

- A. Pressure Transducers. Pressure transducers shall have a linear voltage (0-5 VDC, 1-5 VDC, 0-10 VDC, 2-10 VDC) or current (4-20 mA) output with field adjustable zero and span.

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1. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
- B. Water Pressure Transducers. Water pressure transducers shall have stainless steel diaphragm construction proof pressure of 1 MPa (150 psi) minimum provided with appropriate mounting brackets and a dust and watertight housing with gasket.
 1. Gauge water pressure transducers shall be provided with block and bleed valves.
 2. Differential water pressure transducers over-range differential pressure limit and maximum static pressure shall be 2 MPa (300 psi).
 3. Differential water pressure transducers shall be provided with five-valve manifold for isolation, bypass and bleed.

2.14 PRESSURE SWITCHES

- A. Differential Pressure Switches. Differential pressure switches provided as a part of this specification shall be UL-Listed, SPDT snap-acting, pilot-duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified.
 1. Snubbers shall be provided for all water pressure transducer/switch connections to prevent system pressure hammers and surges from being fully transmitted to the pressure sensor.

2.15 FLOW SWITCHES

- A. Flow Proving Switches. Flow proving switches provided as a part of this specification shall be differential pressure type UL-Listed, SPDT snap-acting, pilot-duty rated (125 VA minimum), NEMA 2 enclosure, with scale range and differential suitable for intended application or as specified.

2.16 RELAYS

- A. Control Relays. Control relays shall be UL-Listed, enclosed with LED energized indicator. Contact rating, configuration, and coil voltage shall be suitable for application. Coil current shall be less than 50 mA.

2.17 TEMPERATURE CONTROL PANELS

- A. Temperature Control Panels. Pedestal base or wall mounted local control enclosures to be fully enclosed NEMA 1 (IEC IP20) at a minimum with hinged door, key-lock latch, and removable subpanels to house all control components appropriate to the environment, service, and/or as required by the code enforcing authorities and other AHJ.
 1. All enclosures shall be UL-Listed.
 2. Enclosures in mechanical rooms shall meet NEMA 2 (IEC IP21) requirements at a minimum or as directed by the AHJ.
 3. Enclosures in all locations not requiring NEMA 2 (IEC IP21) including occupied spaces, above ceilings, and plenums shall be the same NEMA (IEC)

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classification as other enclosures located in the same environment, except if location requires additional protection due to potential vandalism or environmental conditions or as directed by the AHJ.

4. Enclosures exposed to moisture, in wet mechanical rooms or located outdoors shall be meet NEMA 4X (IEC IP66) requirements or as directed by the AHJ.
5. Unless otherwise required by local codes and/or AHJ, all enclosures shall be a minimum of 16-gauge steel or aluminum, totally enclosed on all sides and powder coated or painted with a baked enamel finish.

2.18 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies & Control Transformers. Control transformers and power supplies shall be UL-Listed. Provide Class 2 current-limiting type or over-current protection in both primary and secondary circuits for Class 2 service not to exceed 100 VA in accordance with the applicable following requirements or as directed by the AHJ.
 1. NEC 2011 (NFPA 70) Chapter 7 Article 725 – Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
 2. NEC 2011 (NFPA 70) Chapter 9 Table 11(A) and Table 11(B).
 3. Canadian Electrical Code, Part 1 (CSA C22.1-12) Rule 16-200.
- B. DC Power Supplies. DC power supply output shall match output current and voltage requirements. Power supply shall be half-wave rectified type with the following minimum specifications:
 1. Output ripple: 5.0 mV maximum peak-to-peak.
 2. Regulation: 1.0% line and load combined.
 3. Response: 100 ms for 50% load changes.
 4. Built-in overvoltage and overcurrent protection and able to withstand a 150% current overload for a minimum of three (3) seconds without tripping or failure.
- C. Power Line Filtering. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component.

2.19 INTERCONNECTING WIRING & RACEWAYS

- A. Wiring & Cable. All wiring regardless of service and/or voltage shall comply with the Contract Document Electrical System Specifications, the National Electric Code (NEC), CSA C22.1-12 and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ).
 1. All insulated wire to be copper conductors, UL labeled for 90 °C minimum service.

END OF PART 2

PART 3 - EXECUTION

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3.01 PROJECT REQUIREMENTS

- A. Responsibility. The System, all its components, execution, and compliance with this specification is the responsibility of the System Contractor.
 - 1. Unless specified otherwise, all System devices and components as required to appropriately satisfy the intent of the specified Sequence of Operations, the requirements of the contract drawings, and of this specification shall be provided as a part of this section.
 - 2. All control system components shall be installed in locations as required to properly sense the controlled medium and perform per the intent of the specified Sequence of Operations, the requirements of the contract drawings, and of this specification
- B. Statement of Compliance. The System Contractor must submit a Statement of Compliance to the Owner, Owner's Agent, and/or Contract Officer that details compliance with the specification requirements in a spreadsheet format.
 - 1. The Statement of Compliance must be received by the Owner, Owner's Agent, and/or Contract Officer a minimum of fourteen (14) days prior to the bid/tender date; and must be received prior to submitting any proposals or pricing.
 - 2. The Statement of Compliance must detail each DDC component including at a minimum all controllers, communicating sensors, network components, software, server and workstation hardware, as well as any other components to be provided as a part of this specification as directed by the Owner, Owner's Agent, Contract Officer, and/or Engineer.
 - 3. For each DDC component, the individual model/type and version to be provided under this specification must be represented in the Statement of Compliance complete with Specification clause, Tag, Manufacturer, Make, Model, Version, and Quantity.
 - 4. For any DDC component that complies with all specification requirements, a single line may be entered in the Statement of Compliance indicating simply:
 - a. "Complies with all requirements as specified".
 - 5. For any component that does not comply with all specification requirements, each clause of this specification that is applicable to the component must be listed in the Statement of Compliance; and for each clause the System Contractor must indicate either:
 - a. "Comply", or
 - b. "Does Not Comply".
 - 6. If all DDC components comply with all specification requirements, a signed statement on company letterhead may be submitted indicating:
 - a. "This serves to certify that all DDC components comply with the requirements of every clause as specified".

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7. If, after having submitted a Statement of Compliance indicating that a DDC component is in-compliance with the requirements of the specification, a component is found to be non-compliant, it shall be the responsibility of the System Contractor to replace the component at no additional charge with a compliant component at the discretion of the Owner, Owner's Agent, Contract Officer, and/or Engineer.
 8. If a DDC component is omitted from the Statement of Compliance and is found to be non-compliant, it shall be the responsibility of the System Contractor to replace the component at no additional charge with a compliant component at the discretion of the Owner, Owner's Agent, Contract Officer, and/or Engineer.
 9. If a Statement of Compliance is not submitted, it shall be the responsibility of the System Contractor to replace any non-compliant component(s) at no additional charge with a compliant component at the discretion of the Owner, Owner's Agent, Contract Officer, and/or Engineer.
- C. Ownership. All hardware, databases, application programming, and data provided by, and/or resultant from, the System provided under this specification shall become the exclusive property of the Owner.
- D. BACnet Virtual Private Network (B/VPN). All BACnet internetwork communication between separate broadcast domains shall be required to be secured using a BACnet Virtual Private Network (B/VPN).
- E. SNTP Time Synchronization. The system time of all BACnet devices on the internetwork must be automatically synchronized using SNTP.
1. The System shall be automatically synchronized with a Simple Network Time Protocol (SNTP) server (e.g., us.pool.ntp.org, ca.pool.ntp.org, etc.).
 2. The System shall automatically synchronize controller clocks from a designated Time Master at a minimum of once per hour via the internetwork.
- F. Training. Provide four (4) days of on-site or classroom training sessions throughout the contract period for personnel designated by the Owner and as required in this specification.
1. Provide two (2) days of training immediately following demonstration and acceptance.
 2. Provide one (1) day of training each at 6 and 12 months following demonstration and acceptance or as directed by the Owner.

3.02 QUALITY ASSURANCE

- A. Examination. The System Contractor shall thoroughly examine the contract documents, drawings, and project site to verify that all equipment, enclosures, and devices may be installed as shown and will operate as intended consistent with the project specifications and Sequences of Operation.
1. Any discrepancies, conflicts, or omissions shall be reported to the Engineer and/or project Construction Management team for resolution before rough-in work is initiated.

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- B. Protection. The System Contractor shall be responsible for System work and equipment until finally inspected, tested, and accepted.
 - 1. Work shall be protected against theft or damage.
 - 2. Materials and equipment received on site but not immediately installed shall be carefully stored.
 - 3. All open ends of work shall be closed with temporary covers or plugs during storage and construction to prevent damage/contamination by foreign objects and construction debris.
- C. Quality Control.
 - 1. The System Contractor shall be responsible for inspection and Quality Control (QC) for all materials and workmanship provided under this specification section.
 - 2. The System Contractor shall continually monitor the field installation of System components for code compliance and quality of workmanship and shall have all work inspected as required by local and/or regional code enforcing authorities and/or AHJ.
 - 3. Upon request from the Owner or Engineer, the System Contractor shall present the following:
 - a. Certification of technical training from the System Manufacturer including hours of instruction and course outline for each installer, technician, and application engineer that will be involved on this project.
 - b. Resumes for each installer, technician, application engineer, and project manager that will be involved on this project.
 - c. References from previous projects of comparable scope, type, and service specified.
 - d. All qualifications shall be provided within seven (7) calendar days of initial request.
 - 4. The System Contractor shall maintain a comprehensive service office within 160 km (100 miles) of the project location by the bid date and at a minimum until the completion of the warranty period.
 - a. Comprehensive service office shall be defined as a full-time operational center where System professionals are regularly employed performing at a minimum the responsibilities and services of installation, design, application engineering, service, and project management of complete Systems consistent in scope, type, and service specified for this project.
- D. General Workmanship. System installation shall be performed by professionals in a workmanlike manner consistent with acceptable industry standards for performance and in compliance with the contract documents, project electrical system specifications, the National Electric Code (NEC), CSA C22.1-12, and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ) and in compliance with the following at a minimum:

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1. Installation of all DDC devices, enclosures, wiring, equipment, control devices, and sensors shall be installed in accordance with the manufacturers' recommended installation procedures and as specified.
2. All control devices are to be provided and installed complete with all required gaskets, seals, flanges, connection enclosures, thermal compounds, insulation, piping, fittings, and valves as required for design operation, isolation, equalization, purging, and calibration.
3. Install all equipment as to be readily accessible as defined by Chapter 1, Article 100, Part A of the National Electric Code (NEC) and such that it provides sufficient clearance for system maintenance, component service, calibration, removal, repair, or replacement.
4. Install all equipment, piping, and wiring/raceway parallel or perpendicular to building lines.
5. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
6. All control devices mounted outdoors shall be protected by a weather-shield, integral outdoor enclosure, etc., and from ambient elements in such a manner as to not impede design functionality and/or sensing.
7. Dielectric isolation shall be provided where dissimilar metals are used in installation for connection and support.
8. Penetrations through, and mounting holes in, the building exterior associated with the System installation shall be sealed and made water-tight.

E. Coordination.

1. Where work will be installed near, or will interfere with, work of other trades, all contractors are responsible for coordinating space requirements.
 - a. Coordinate and schedule work with all other trades in the same area, or with work that is dependent upon other trades to facilitate mutual progress.
 - b. Report all conflicts and anticipated delays to the project Construction Management team for resolution immediately upon identification.
2. Test and Balance.
 - a. The System Contractor shall furnish one (1) full set of all tools necessary to interface to the System for test and balance purposes.
 - b. The System Contractor shall provide four (4) hours of training in the use of tools necessary to interface to the System for test and balance purposes.
 - c. The System Contractor shall provide a qualified technician to assist in the test and balance process until for a period of eight (8) hours, or until the first twenty (20) terminal units have been balanced, or 20% of the terminal units have been balanced (whichever is less).

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3. Life Safety Coordination.

- a. Duct smoke detectors required for equipment shut down are furnished under another division of the specification. The System Contractor shall interlock smoke detectors to air handling units for shut down as described in the Sequences of Operation.
- b. Smoke dampers and actuators required for duct smoke isolation are provided under another division of the specification. The System Contractor shall interlock smoke dampers to air handling units as described in the Sequences of Operation.
- c. Fire/smoke dampers and actuators required for fire rated assemblies are provided under another division of the specification. Control of these dampers shall be by another division of the specification.

4. Original Equipment Manufacturer (OEM) Provided Controls. All OEM and/or vendor package DDC control systems, controls, and devices provided under any specification section for this project shall completely comply with all requirements of this specification section.

- a. The provider(s) of the OEM equipment/controls shall bear exactly the same burden of responsibility for products provided as those required of the System Contractor in this specification section.
- b. A Protocol Implementation Conformance Statement (PICS) including a BACnet Interoperability Building Block (BIBB) table shall be provided for any DDC device (hardware and software) provided to be integrated to the System.
- c. All communication and network media and equipment integrated with the System provided by any Contractor or Vendor must comply with the requirements of this specification.
- d. The Contractor, Supplier, and/or Vendor furnishing and/or providing any controls products to be integrated to the System are responsible for the configuration, programming, start-up, testing, and proof-of-performance of that product to meet the requirements of this specification and all Sequences of Operation. Functional performance of controls products to be integrated to the System in compliance with this specification shall not be responsibility of the System Contractor.
- e. The System Contractor shall coordinate resolution of incompatibilities that arise between the control products provided as a part of this section and products provided as a part of other sections or divisions of the specification. Final responsibility for any product resides with the Contractor or Vendor providing the product.

3.03 WARRANTY

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- A. Hardware. The System Manufacturer shall provide a warranty certificate covering all DDC devices and controllers for a period of at least five (5) years following final acceptance.
 - 1. If a five (5) year warranty is not available from the System Manufacturer, the remainder of the required warranty period shall be provided by the System Contractor.
- B. Software. The System Manufacturer shall provide a warranty certificate covering all software and computer hardware provided for a period of at least twelve (12) months following final acceptance.
- C. Labor and Materials. The System Contractor shall warrant labor and materials provided under this specification to be free from defects for a period of at least twelve (12) months following final acceptance.
- D. Warranty Date. All work shall have a single warranty date, even if the owner receives beneficial use due to early system start-up.
 - 1. If specified work is split into multiple contracts or in the event of a multiphase contract, each contract or phase shall have a separate warranty start date and period.
 - 2. Within seven (7) days of determining that the equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the Owner, Owner's Agent, Contract Officer, and/or Engineer will certify in writing that System operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin the warranty period.
 - 3. System failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.
 - 4. Warranty service response shall be during normal business hours within twenty-four (24) hours of the Owner's warranty service request.
 - a. Except in the event of property loss or damage, or as indicated otherwise in the Contract Documents, warranty service shall be provided during regular working hours Monday through Friday.
 - 5. Operator workstation software, project-specific software, graphic software, database software, and firmware provided under this specification required to resolve deficiencies shall be provided at no charge during the warranty period. If available, the owner can purchase an in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items.
 - a. After acceptance of the System, the System Contractor shall not install updates or upgrades without the Owner's written authorization.
 - 6. The System Contractor shall not be required to warrant any device(s) required to be reused except those that have been rebuilt or repaired.

3.04 SYSTEM ARCHITECTURE

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- A. BACnet. All communication shall be provisioned to conform with ANSI/ASHRAE Standard 135, BACnet.
 1. At the explicit direction of the Owner, proprietary building equipment and/or systems may be integrated to the System using protocol gateways consistent with the following requirements:
 - a. Each individual piece of equipment or building system must be provided with one (1) dedicated gateway.
 - b. The gateway must be installed within 3m (10') of the equipment or building system requiring the gateway.
 - c. All hardware, software, accessories, enclosures, interconnecting cable, connectors, etc., required for the complete installation of the gateway must be provided by the Contractor, Supplier, and/or Vendor furnishing and/or providing the equipment or building system requiring the gateway.
 - d. The Contractor, Supplier, and/or Vendor furnishing and/or providing the equipment or building system and gateway(s) to be integrated to the System are responsible for the configuration, programming, start-up, testing, and proof-of-performance of that product to meet the requirements of this specification and all Sequences of Operation. Functional performance of equipment or building system and gateway(s) to be integrated to the System in compliance with this specification shall not be responsibility of the System Contractor.
 - e. The Contractor, Supplier, and/or Equipment Vendor furnishing and/or providing the equipment or building system and gateway(s) to be integrated to the System shall be responsible for all support and warranty of the gateway(s) provided.
- B. Assurance. All System internetwork components (including controllers, software, protocol routers, etc.) provided and installed under this specification shall be tested, certified, clearly stamped, and listed by the BACnet Testing Laboratories (BTL) a minimum of thirty (30) days prior to the bid date for this project.
 1. A Protocol Implementation Conformance Statement (PICS) including a BACnet Interoperability Building Block (BIBB) table shall be provided for each DDC device (hardware and software) provided under this specification.
 2. BTL product listings are available from BACnet International (<http://www.bacnetinternational.net/btl/>).
- C. Network Architecture. The System as provided and installed under this specification shall be designed to consist of three network architecture levels as described in the General Part, System Architecture clauses of this specification.
 1. Tier 3 FLCNs shall use one the following data links only:
 - a. BACnet/IP: ANSI/ASHRAE Standard 135 Annex J.
 - b. B/VPN: BACnet Virtual Private Network.

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- c. ISO 8802-3 (Ethernet): ANSI/ASHRAE Standard 135.7.
 - d. Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.
 - 2. All other BACnet data links not explicitly listed in this section shall be strictly prohibited from this project.
- D. FLCNs. No single FLCN MS/TP (Master Slave/Token-Passing) segment provided and installed under this specification shall exceed 32 full-load nodes.
 - 1. For the purposes of this specification, any BACnet device that does not support the BACnet Read Property Multiple (RPM) service shall be considered a full-load node, and installed accordingly.
 - 2. For the purposes of this specification, any BACnet device that does not support BACnet Segmentation for both Transmit and Receive shall be considered as a full-load node, and installed accordingly.
 - 3. FLCNs must be designed and deployed as to efficiently communicate at a baud of 76.8 Kbps under normal network operational conditions with all devices executing the specified Sequences of Operation at the specified performance criteria.
 - a. Any device that cannot efficiently communicate at a baud of 76.8 Kbps under normal network operational conditions must be installed on a dedicated network.
- E. Network Transparency. The System as provided and installed under this specification shall be configured in such a way that the network architecture shall be transparent to the internetwork operator interface and BACnet communication.
 - 1. BACnet communication shall be automatically routed to all configured BACnet networks using standard BACnet services by controllers on the internetwork.
 - 2. Dedicated, stand-alone BACnet routers and/or routing devices shall not be acceptable.
- F. Dedicated Local Control. Each mechanical system and/or piece of mechanical equipment shall be controlled by one (1) dedicated DDC device with sufficient hardware and software capabilities that it shall be connected to all field devices associated with the mechanical system and/or piece of mechanical equipment.
 - 1. Distributed control of one (1) mechanical system and/or piece of mechanical equipment by multiple controllers shall be strictly prohibited.

3.05 CONTROLLERS

- A. Compliance. All controllers provided under this specification shall be provisioned as described in this specification clause and in compliance with all other relevant specification clauses.
- B. BACnet Communication. All controllers shall be provisioned to support the following communication requirements at a minimum:
 - 1. Client and Server BACnet Subscribe Change of Value (COV) service.

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2. Client and Server BACnet Read Property Multiple (RPM) service.
 3. BACnet transmit and receive frame segmentation.
 4. Post-installation, field-configurable maximum information frames, APDU frame timeout, APDU segment timeout, and APDU retries.
- C. Communication Management. Each controller shall be configured to manage its own BACnet communication transactions to permit distributed devices to access real-time object information for global strategies, monitoring, and alarms. All controller-to-controller communication shall be peer-to-peer and shall not require a master device, server, or network management device to facilitate communication.
1. No single device may be configured to manage the communication for the entire internetwork.
 2. No single device may be configured to manage normal BACnet communication for another device.
 3. No device may inherently change the payload (e.g., change the write priority) of a BACnet frame in transit or while being routed.
 4. Standard BACnet routing from one network to another network in the internetwork by a BACnet router is acceptable.
 5. The contractor must be prepared to demonstrate, upon request, that all BACnet communication is being managed by the originating client and destination server devices.
- D. Local Database. All logic required to perform the specified Sequences of Operation, trending, and alarming as outlined in this specification shall reside in each individual controller.
1. Each controller shall execute all specified local control strategies without reliance upon any other device indefinitely in the event of communication failure.
 - a. Trim-and-respond and/or demand-based reset control logic shall be programmed with functional fail-safe parameters for stand-alone operation in the event that network objects such as outdoor air temperature, space temperatures, or terminal loads are not available.
 2. Controllers that require any level of supervisory server software or hardware or any external platform to manage database execution or network management shall not be permitted as a part of the System provided pursuant with this specification.
- E. Controller Selection. Each mechanical system or piece of equipment shall be provided with one dedicated controller with sufficient memory and hardware points necessary to satisfy the specified Sequence of Operation and to comply with the requirements of all applicable System specifications.
1. All physical inputs and outputs necessary to satisfy the specified Sequence of Operation shall be physically connected to the controller executing the control logic.

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- a. Objects used for trim-and-respond and/or demand-based reset control such as outdoor air temperature, space temperatures, or terminal loads shall not be required to be hosted on the controller executing the control logic.
- 2. Multiple pieces of mechanical equipment comprising one mechanical system (e.g., multiple pumps in a pumping system, or chillers in a chilled water system, etc.) may be controlled by a single controller provided all the hardware points associated with all the equipment are physically connected to the controller executing the control logic.
- 3. Distributed control of one piece of mechanical equipment shall not be performed by multiple controllers.
- F. Serviceability. All wiring connections shall be made to field-removable, modular terminal strips.
- G. Online Database Manipulation. All controllers must support online modification of individual objects (including but not limited to inputs, outputs, values, loops, schedules, programs, graphical displays, and logs) in real-time while operational without impacting other elements of the database or the functionality of the controller.
 - 1. Creating, deleting, and/or modifying an object shall not require downloading the entire database to the controller. Excepting for the objects being manipulated, it shall not interrupt the operation of the controller.
 - 2. Compiling one program shall not affect the execution of other programs.
 - 3. Manipulation of database objects shall not impact the ability of the operator to access/use the GUI.
- H. Operator Override. All controllers shall support operator-initiated timed overrides of hardware and software objects.
 - 1. When the operator-configured override period has expired, the controller shall automatically return the object to the automatic state without any additional action on the part of the Operator.
 - 2. The timed override functionality shall exist entirely in the controller. A workstation shall not be required for the execution of the override period nor for returning the object to automatic.
- I. Updates. The operator shall have the ability to update the operating system firmware of any controller provided under this specification at any time after installation, utilizing the BACnet internetwork.
 - 1. Operating system firmware that requires chip replacement or flash modification shall be strictly prohibited.

3.06 FIELD-LEVEL SYSTEM CONTROLLERS

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- A. Compliance. Field-level system controllers shall be provisioned as described in this specification article and in compliance with all other relevant specification clauses.
- B. Provide one (1) dedicated field-level system controller per major mechanical system and/or equipment as required per the contract documents, drawings, equipment schedules, and/or as follows:
 - 1. All mechanical equipment and systems with a common application shall be provided with the same controller model.
- C. BACnet Device Profile. Field-level system controllers shall be certified and Listed by the BACnet Testing Laboratories (BTL) in compliance with the minimum requirements of ANSI/ASHRAE Standard 135-2012 Revision 14 Annex L a minimum of 30 days prior to the bid date for this project as follows:
 - 1. BACnet Building Controller (B-BC).
- D. BACnet Network Architecture. Field-level system controllers shall be installed on the following network and data link:
 - 1. Tier 3 Field Level Communication Network (FLCN).
 - a. Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.
- E. BACnet Communication. All field-level system controllers shall be provisioned to support the following communication requirements:
 - 1. A minimum of 124 BACnet client network read requests and/or COV subscriptions and a minimum of 64 BACnet client network write requests and/or COV server notifications.
- F. Physical Networking. All field-level system controllers provided under this specification are required to be provisioned such that the following intrinsic physical communication networks are licensed and enabled simultaneously at a minimum:
 - 1. One (1) TIA-232 port @ 115.2 Kbps.
 - 2. One (1) TIA-485 port @ 76.8 Kbps.
- G. Protocol. All field-level system controllers provided under this specification are required to be provisioned such that the following intrinsic communication protocols and data links are licensed and enabled simultaneously at a minimum:
 - 1. ANSI/ASHRAE Standard 135: BACnet.
 - a. One (1) Point-to-Point (PTP): ANSI/ASHRAE Standard 135.10.
 - b. One (1) Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.
- H. Hardware. Field-level system controllers shall be installed and/or provisioned per the following requirements:
 - 1. Each field-level system controller shall be provided with an integral power switch or a dedicated fused transformer and switch inside the enclosure.

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2. All field-level system controller physical inputs shall be provided with a proportional brightness LED to display the status of each individual input.
3. All field-level system controller physical outputs shall be provided with a proportional brightness LED to display the status of each individual output.
4. Field-level system controllers shall be selected to provide a minimum of 10% spare I/O point capacity on each controller.
 - a. Where universal inputs are not provided, 10% spare inputs of each individual type (e.g., analog, binary, etc.) are required.
 - b. Where universal outputs are not provided, 10% spare outputs of each individual type (e.g., analog, binary, etc.) are required.
5. All field-level system controller physical outputs shall be provided with a physical Hand/Off/Auto (HOA) switch.
 - a. All analog outputs shall also be provided with a potentiometer for manual adjustment of voltage signal in the Hand position.
 - b. HOA switch position feedback shall be monitored and displayed by the operating system of the controller.
 - c. Controller shall alarm when each HOA switch is not in the Auto position.
 - d. If the controller does not provide integral HOA switches and potentiometers, they shall be installed external to the controller, and in the same enclosure as the controller.

3.07 FIELD-LEVEL EQUIPMENT CONTROLLERS

- A. Compliance. Field-level equipment controllers shall be provisioned as described in this specification article and in compliance with all other relevant specification clauses.
- B. Provide one (1) field-level equipment controller per mechanical system and/or equipment as required per the contract documents, drawings, equipment schedules, and/or as follows:
 1. All mechanical equipment and systems with a common application shall be provided with the same controller model.
- C. BACnet Device Profile. Field-level equipment controllers shall be certified and Listed by the BACnet Testing Laboratories (BTL) in compliance with the minimum requirements of ANSI/ASHRAE Standard 135-2012 Revision 14 Annex L a minimum of 30 days prior to the bid date for this project as follows:
 1. BACnet Building Controller (B-BC).
- D. BACnet Network Architecture. Field-level equipment controllers shall be installed on the following network and data link (as indicated):
 1. Tier 3 Field Level Communication Network (FLCN).
 - a. BACnet/IP: ANSI/ASHRAE Standard 135 Annex J.

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- b. B/VPN: BACnet Virtual Private Network.
 - c. ISO 8802-3 (Ethernet): ANSI/ASHRAE Standard 135.7.
 - d. Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.
- E. BACnet Communication. All field-level equipment controllers shall be provisioned to support the following communication requirements:
 - 1. A minimum of 256 BACnet client network read requests and/or COV subscriptions and a minimum of 128 BACnet client network write requests and/or COV server notifications.
- F. Physical Networking. All field-level equipment controllers provided under this specification are required to be provisioned using the following physical communication networks (one of the following at a minimum):
 - 1. One (1) TIA-485 port @ 76.8 Kbps.
 - 2. One (1) ISO 8802.3 Ethernet (10/100 BaseT).
 - 3. One (1) ISO 8802.3af PoE (10/100 BaseT).
 - 4. One (1) ISO 8802.11b/g/n Wi-Fi.
- G. Protocol. All field-level equipment controllers provided under this specification are required to be provisioned such that the following communication protocols and data links are supported:
 - 1. ANSI/ASHRAE Standard 135: BACnet (one of the following at a minimum).
 - a. One (1) Master Slave Token Passing (MS/TP): ANSI/ASHRAE Standard 135.9.
 - b. One (1) ISO 8802-3 (Ethernet): ANSI/ASHRAE Standard 135.7.
 - c. One (1) BACnet/IP: ANSI/ASHRAE Standard 135 Annex J.
 - 2. Dynamic Host Configuration Protocol (DHCP) as a client.
 - a. The ability for dynamic assignment of IP address, mask, and gateway by the DHCP server for the network shall be supported.
 - 3. Simple Mail Transfer Protocol (SMTP).
 - a. Transport Layer Security (TLS) for SMTP must be supported including compatibility with standard free email services (e.g., *Gmail*, *Yahoo!*, *Outlook.com*).
 - b. The ability to manage custom TLS certificates from SMTP must be supported.
 - c. The ability to transmit a simple test email to verify SMTP configuration with a single operator action (e.g., pressing a *Test Email* button) must be provided.
 - 4. Simple Network Time Protocol (SNTP) as a client.

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- a. The ability for embedded system time to be synchronized by an operator-configurable SNTP server shall be supported.
- 5. Transmission Control Protocol (TCP).
 - a. Connection to the BACnet internetwork utilizing standard BACnet services on Transport Layer Protocol (TCP) shall be supported, encrypting all data using SSL/TLS and secured using authenticated credentials and shall support custom encryption keys and authentication certificates.
- 6. Wi-Fi.
 - a. Devices with Wi-Fi provided under this specification must support WPA and WPA2 protected access.
- 7. If any additional hardware including communication cards, ports, licenses, or gateways are required to support these networks they must be provided as a part of this contract. Any additional hardware must be warranted by the manufacturer as proven by a certificate from the manufacturer for a period of five (5) years at a minimum.
- H. Hardware. Field-level equipment controllers shall be installed and/or provisioned per the following requirements:
 - 1. There shall be a provision for at least one spare, universal, software-selectable input on each field-level equipment controller after the requirements of the Sequence of Operation specified in the contract documents have been satisfied.
 - a. Where universal inputs are not available, one (1) spare analog input and one (1) spare binary input shall be required on each building-level equipment controller.
 - b. Where software-selectable inputs are not available, one (1) input of each required physical characteristic (e.g., thermistor, dry-contact, voltage, and current) shall be required on each building-level equipment controller.
 - 2. There shall be a provision for at least one spare jumper-selectable output on each field-level equipment controller after the requirements of the Sequence of Operation specified in the contract documents have been satisfied.
 - a. Where outputs are not jumper-selectable to provide both universal and relay service, one (1) spare analog output and one (1) spare binary output shall be required on each building-level equipment controller.

3.08 FIELD-LEVEL OPERATOR DISPLAY

- A. Compliance. Field-level operator displays shall be provisioned as described in this specification article and in compliance with all other relevant specification clauses.
 - 1. Field-level operator displays shall be required to comply with all the requirements for field-level equipment controllers in addition to those prescribed in this specification clause.

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- B. Provide one (1) field-level operator display integral to each building-level equipment controller as required per the contract documents, drawings, equipment schedules, and/or as follows:
 - 1. All mechanical equipment and systems with a common application shall be provided with the same controller model.
- C. BACnet Device Profile. Field-level operator displays shall be certified and Listed by the BACnet Testing Laboratories (BTL) in compliance with the minimum requirements of ANSI/ASHRAE Standard 135-2012 Revision 14 Annex L a minimum of 30 days prior to the bid date for this project as follows:
 - 1. BACnet Building Controller (B-BC), and
 - 2. BACnet Operator Display (B-OD).
- D. Integral Operator Display. Field-level operator displays as provided shall deliver a high-level operator interface environment through an integrated full-color, touch screen display in compliance with the product clause requirements and according to the following minimum criteria:
 - 1. The display environment shall be operator-adjustable including:
 - a. Backlighting.
 - b. Brightness.
 - c. Color scheme.
 - d. Degrees Fahrenheit/Celsius.
 - e. Language.
 - f. Audible alarm notification.
 - g. Display time-out/always-on.
 - 2. The operator display shall be provisioned such that the engineering units and language shall be selectable by the operator from the display or dynamically assignable through system-level interfaces (e.g., Graphical User Interfaces (GUIs), Browser-based User Interfaces (BUIs), mobile device apps, etc.). The following languages must be provisioned at a minimum:
 - a. English,
 - b. French,
 - c. Spanish,
 - d. German,
 - e. Italian,
 - f. Portuguese, and
 - g. Simplified Chinese.

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3. The operator display shall be configured with a multilayer password-protection.
 - a. Password, passcode, or PIN shall be configured to restrict/permit day-to-day operations and system configuration.
 - b. Each display shall be shown or hidden based upon the operator password.
 - c. An administrator shall be provided with the ability to apply security to permit/restrict modification of each individual object on any display.
 - d. The operator display shall be configured such that each operator shall be automatically logged-off after a configurable period of inactivity.
4. The operator display shall be provisioned to deliver the following:
 - a. A minimum of 32 separate displays/screens each supporting a minimum of 32 objects for a total display of a minimum of 1024 objects.
 - b. The operator shall have the ability to command the present value of all hardware and software objects in the local device as an automatic write, permanent override, or temporary override using standard BACnet priorities.
 - c. The operator shall have the ability to command the present value of a minimum of 256 objects from the BACnet Internetwork as an automatic write, permanent override, or temporary override using standard BACnet priorities.
 - d. The operator shall have the ability to view/modify BACnet Schedule objects.
 - e. The operator shall have the ability to view BACnet Trend Log objects.
 - f. The operator shall have the ability to view/modify BACnet Alarms. Unacknowledged alarms shall be annunciated with a clearly discernable display indication (e.g., icon, color-change, etc.) and operator-configurable audible notification.
5. The operator shall have the ability to initiate timed overrides of hardware and software objects with configurable override periods via the operator display.
 - a. When the override period has expired, the controller shall automatically return the object to the automatic state without any additional action on the part of the operator.
 - b. All manual operator commands shall be performed using BACnet priorities and properties.
 - c. The operator display shall be programmed to indicate objects that are presently manually overridden.
 - d. For timed overrides, the operator display shall be programmed to show the amount of time remaining until the object reverts to automatic.

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- e. The timed override functionality shall exist entirely in the controller. A workstation shall not be required for the execution of the time nor for returning the object to automatic.

3.09 COMMUNICATING SPACE SENSORS

- A. Warranty. Each communicating space sensor must be warranted by the manufacturer as proven by a certificate from the manufacturer for a period of five (5) years at a minimum.
- B. The System shall be configured to actively monitor the communication status and reliability of all communicating sensors.
 - 1. When communication is lost with any communicating sensor, the system shall be configured to generate an alarm and to perform an automatic control strategy fail-safe response until communication is restored.
 - 2. If the system is not capable of performing custom, freely-programmable, and automatic control strategy response as a result of a loss of sensor communication, communicating sensors may not be used.
- C. Hardware. Only one (1) communicating space sensor series shall be provided under this specification. The communicating space sensor series of products provided under this specification must be available with the following the integral hardware at a minimum:
 - 1. Temperature.
 - 2. Setpoint.
 - 3. Relative Humidity.
 - 4. Unoccupied Bypass.
 - 5. PIR Occupancy.
 - a. Range: 5m/16'.
 - 6. CO₂.
 - 7. Auxiliary onboard inputs.
 - a. Thermistor or dry-contact.
 - 8. Auxiliary onboard outputs.
 - a. Dry-contact outputs.
 - 9. Front-lighting or Back-lighting.
- D. Tamper-proof. Communicating space sensors provided under this specification shall be available as a stainless-steel or aluminum plate for tamper-proof applications in public spaces, corridors, restrooms, gymnasiums, etc.
 - 1. Tamper-proof communicating space sensors shall cover a standard, single-device utility box.

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2. Tamper-proof communicating space sensors shall be available with the following the integral hardware at a minimum:
 - a. Temperature.
 - b. Unoccupied Bypass.
- E. Except for in tamper-proof installations, each communicating space sensor shall be provided with a keypad and display to permit low-level operator interface with following features at a minimum:
 1. Configurable to display icons, time, point names and engineering units.
 2. Configurable to display and modify object values from any device on the internetwork.
 - a. Provide access to a minimum of ten (10) total object values.
 3. All communicating space sensors shall be configured to allow the operator to select degrees Fahrenheit or degrees Celsius for displaying all temperatures.
 4. All communicating space sensors shall be configured to allow the operator to select the display language. The following languages shall be supported at a minimum:
 - a. English.
 - b. French.
 - c. Spanish.
 - d. Portuguese.
 - e. German.
 - f. Italian.
 - g. Simplified Chinese.

3.10 COMMUNICATING DUCT SENSORS

- A. Warranty. Each communicating duct sensor must be warranted by the manufacturer as proven by a certificate from the manufacturer for a period of five (5) years at a minimum.
- B. The System shall be configured to actively monitor the communication status and reliability of all communicating sensors.
 1. When communication is lost with any communicating sensor, the system shall be configured to generate an alarm and to perform an automatic control strategy fail-safe response until communication is restored.
 2. If the system is not capable of performing custom, freely-programmable, and automatic control strategy response as a result of a loss of sensor communication, communicating sensors may not be used.

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- C. Enclosure. Communicating duct sensors provided under this specification shall be available with the following enclosures at a minimum:
 - 1. Galvanized box.
 - 2. Plastic box.
- D. Hardware. Communicating duct sensors provided under this specification shall be available with the following the integral hardware at a minimum:
 - 1. Temperature.
 - a. -40 to 120°C (-40 to 250°F)
 - b. Duct probe lengths 4" to 18".
 - 2. Relative Humidity.
 - a. $\pm 2\%$.
 - 3. Auxiliary onboard inputs.
 - a. Thermistor or dry-contact.
 - 4. Auxiliary onboard outputs.
 - a. Dry-contact outputs.

3.11 AUTOMATIC CONTROL DAMPERS

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- B. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- C. Install extended shaft or jackshaft according to manufacturer's instructions.
- D. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 6.4 mm (1/4") larger than damper dimensions and shall be square, straight, and level.
- E. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm (1/8") of each other.
- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- G. Provide a visible and accessible indication of damper position on the drive shaft end.

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- H. Support ductwork in area of damper when required to prevent sagging due to the weight damper sections.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.12 AUTOMATIC CONTROL VALVES

- A. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.
- B. Valves shall be installed in accordance with the manufacturer's recommendations.
- C. Two-way valves shall not be placed on branch or main hydronic circuits where these valves will cause a "dead-head" pumping condition.
- D. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position.
- E. Ball type control valves shall be installed with the stem in the horizontal position.
- F. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
- G. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system.
- H. Unions shall be installed at all connections to screw-type control valves.
- I. Provide tags for all control valves indicating service and number.
 - 1. Tags shall be brass, 4 cm (1.5") in diameter, with 6.4 mm (1/2") high letters.
 - 2. Securely fasten with chain and hook.
 - 3. Match identification numbers as shown on approved controls shop drawings.

3.13 AUTOMATIC CONTROL ACTUATORS

- A. Mount and link all control actuators according to manufacturer's instructions.
 - 1. Check operation of installed damper/valve and actuator assembly to confirm that actuator modulates smoothly throughout full stroke to both open and closed positions.
 - 2. To compress seats when spring-return actuators are used on normally-closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten linkages.
- B. All actuators shall be direct-coupled unless otherwise scheduled or indicated by manufacturer.
- C. Minimum torque and power output requirements of actuators shall not be less than 125% of the required design load.

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- D. When the associated mechanical system or equipment is not in operation, control actuators shall remain in their "off" positions as indicated in the Sequences of Operation.
- E. For automatic control valve actuators, In lieu of a manual positioning device, it will be acceptable for the contractor to provide a full line size bypass around the control valve. Three bypass shut-off valves shall be provided to allow the control valve to be isolated while the bypass allows flow around the control valve.

3.14 TEMPERATURE DEVICES

- A. All sensors shall be installed in accordance with the manufacturer's recommendations consistent with acceptable industry standards for performance compliant with the requirements of this specification.
- B. Mount sensors rigidly and adequately for the environment within the sensor operates.
- C. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings. Where necessary due to structural cavities, masonry walls, proximity to exterior openings, unconditioned spaces, etc. insulated mounting base shall prevent temperature of mounting location from affecting sensor temperature reading.
- D. Space temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type.
- F. All averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- G. Low-limit sensors and/or thermostats used in mixing plenums shall be installed in a serpentine manner horizontally across the duct. Each bend shall be supported with a capillary clip. Provide a minimum of 3 m of sensing element for each 1 m² (1' of sensing element for each 1 ft²) of coil area.
- H. All pipe-mounted sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid or paste in thermal wells.
 - 1. Assembly shall allow removal of sensor from well without loss of measured medium fluid.
- I. Outdoor air sensors shall be mounted outside on a northern exposure as high as serviceable on the building. The sensor shall be mounted within a ventilated enclosure to shield the sensor from the effects of the sun. The sensor location shall be selected such that it may not be affected by artificial and/or mechanical airstreams (i.e., building exhaust, building relief, etc.).
- J. In condensing environments use stainless steel sensing element and capillary mounting clips.
- K. Sensor guards shall be provided to protect sensor from damage in high-impact and/or high-traffic areas and/or where vandalism is a concern.

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- L. Sensors shall be manually calibrated on site so that the wiring length and termination does not detract from the specified sensor accuracy.

3.15 HUMIDITY DEVICES

- A. All sensors shall be installed in accordance with the manufacturer's recommendations consistent with acceptable industry standards for performance compliant with the requirements of this specification.
- B. Mount sensors rigidly and adequately for the environment within the sensor operates.
- C. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings. Where necessary due to structural cavities, masonry walls, proximity to exterior openings, unconditioned spaces, etc. insulated mounting base shall prevent temperature of mounting location from affecting sensor temperature reading.
- D. Space sensors shall be installed on concealed junction boxes properly supported by the wall framing.

3.16 PRESSURE TRANSDUCERS

- A. Locate all pressure transducers (except for those controlling air terminal units) in field device panels, not on mechanical equipment or ductwork, as close as possible to the sensing point and use tubing sized such as to prevent signal phase lag.
- B. Pressure transducer tubing shall be connected to a pitot tube or other pressure/airflow sensing device. Under no circumstances shall tubing pass through equipment housing or ductwork.
 - 1. Pitot tube probe shall be made of brass or aluminum with 8 inches of lead tube allowing insertion into duct.
- C. The piping to pressure ports on all pressure transmitters shall contain a capped test port adjacent to the transmitter.
- D. Static pressure sensing taps shall face down-stream in the airflow to eliminate velocity pressure effects.
- E. Supply and return air duct static pressure transmitters shall have the high-pressure port connected to a pitot tube installed in the ductwork and the low-pressure port shall be left open to the plenum.
 - 1. Supply air duct static pressure transmitter pitot tube shall be located 60-70% of the total distance from the fan unit, and/or after 60-70% of the connected terminal units (whichever is further from the fan unit), and in a straight section of ductwork with a minimum of four (4) duct diameters/widths in both directions.
- F. Positive-static high-pressure safety cut-outs shall be located immediately downstream of the fan section and shall be installed with high-pressure port connected to a pitot tube installed in the ductwork and the low-pressure port shall be left open to the plenum.

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- G. Negative-static high-pressure safety cut-outs shall be located immediately upstream of the fan section and be installed with low-pressure port connected to a pitot tube installed in the ductwork and the high-pressure port shall be left open to the plenum.
- H. Building static pressure sensors shall be installed with the high-pressure port connected to a sensing probe installed in the space and the low-pressure port connected to an outdoor air static pressure sensing probe through a high-volume accumulator.
 - 1. The tubing for both the high-pressure and the low-pressure ports shall be routed through a surge dampener installed between the transmitter and the sensing elements.
- I. Differential pressure taps shall be installed such that true differential of the monitored medium may be accurately sensed.
- J. Wet pressure sensors shall be installed with snubbers and isolation valves.
 - 1. Wet differential pressure sensors shall be installed with five-valve bypass assemblies.

3.17 PRESSURE SWITCHES

- A. Differential pressure type switches shall be installed as per differential pressure transmitters and shall provide a maximum switching differential of 10% of the sensed operating range for the application at minimum and maximum designed flow rates. Setpoint shall be selected to operate at midpoint of span.

3.18 FLOW SWITCHES

- A. All flow switches shall be installed and adjusted in accordance with the manufacturer's recommendations consistent with acceptable industry standards for performance compliant with the requirements of this specification.
- B. Mount flow switches rigidly and adequately for the environment within the sensor operates.
- C. Use the correct paddle material and diameter for the application.

3.19 RELAYS

- A. All relays shall be installed in accordance with the manufacturer's recommendations consistent with acceptable industry standards for performance compliant with the requirements of this specification.

3.20 TEMPERATURE CONTROL PANELS

- A. Unless otherwise directed by the AHJ, all temperature control panels and enclosures shall be located as indicated such that visual observation and adjustment can be accomplished while standing flatfooted on the floor in a convenient location adjacent to the equipment served. Install all equipment in readily accessible location as defined by Chapter 1 Article 100 Part A of the NEC or CSA C22.1-12 Rule 2 (as applicable).
- B. All temperature control panels shall have keyed, locking latches and shall be keyed commonly such that one key shall open all enclosures.

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- C. Provide each DDC panel with a surge suppressor, electrical disconnect, control fuse, and control transformer; all sized and provided by the System Contractor.
- D. Interconnections between internal termination points and face and/or panel-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL-Listed for 600-volt service, individually identified per control drawings with adequate clearance for field connections.
 - 1. Provide insulated, modular, feed-through, clamp-style recessed captive screw-type terminal blocks suitable for rail-mounting with end plates and partitions for the termination of all field wiring in temperature control panels.
 - 2. Field wiring to equipment with integral terminals and/or unitary equipment shall not be required to have terminal blocks.
- E. All high-voltage wiring consistent with the definitions of NEC/CSA Class 1 must be strictly separated by barriers, raceways or sub-panels from low-voltage wiring consistent with the definitions of NEC/CSA Class 2 according to the requirements of the NEC Chapter 7 Article 725 – Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits and the CSA Canadian Electrical Code, Part 1 Rule 16-212 Separation of Class 2 circuit conductors from other circuits.
- F. Provide laminated nameplates or tags for all control system components. Unless otherwise directed in this specification or by the AHJ, nameplates shall be minimum 1 inch by 3 inches (2.5 cm X 7.5 cm), with minimum ¼ inch (6 mm) high block lettering. Nameplates for devices smaller than 1 inch by 3 inches (2.5 cm X 7.5 cm) shall be attached to adjacent surface or connected to the device using a chain.
- G. A legible reproduction of the “As-built” application engineering for the system served shall be laminated in clear plastic and mounted within each enclosure.

3.21 POWER SUPPLIES AND LINE FILTERING

- A. No loads shall exceed 80% of the faceplate rating for each power supply or transformer.

3.22 WIRING

- A. System control wiring shall be performed by professionals in a workmanlike manner consistent with acceptable industry standards for performance and in compliance with the contract documents, Project Electrical System Specifications, the National Electric Code (NEC), CSA C22.1-12 and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ). When non-code compliance requirements of the Electrical System Specifications and this specification section differ, this section shall take precedence.
- B. Unless otherwise specified it shall be the responsibility of the Contractor to provide all the NEC/CSA Class 2 (low voltage) wiring necessary to provide a complete System in compliance with the requirements of this specification.
- C. All wiring consistent with the definitions of NEC/CSA Class 1 (line voltage) shall be installed in UL-Listed raceway or conduit according to the requirements of the NEC,

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CSA C22.1-12, the Electrical System Specifications and any/all applicable local codes and/or AHJ.

- D. All wiring consistent with the definitions of NEC/CSA Class 2 (low voltage) control wiring shall be sub-fused as required and installed according to the requirements of the NEC, CSA C22.1-12, the Electrical System Specifications and any/all applicable local codes and/or AHJ.
- E. Class 2 wiring concealed in accessible locations not installed in UL-Listed raceways or conduit may be used provided that the cable is UL-Listed for the intended application.
 - 1. When Class 2 wiring is installed exposed, wiring is to be routed parallel or perpendicular (right-angles) with building and/or mechanical lines and neatly tied at 1.5 m (5') intervals.
 - 2. Exposed cabling shall be mechanically supported to structural members. Cables shall not be supported by, or anchored to: ductwork, electrical raceways, piping or ceiling suspension systems.
 - 3. Exposed cabling shall be installed in sleeves where the route passes through walls, floors, and other partitions. Maintain fire, smoke, envelope, and pressure ratings of each space.
- F. All wiring in mechanical, electrical or service rooms, or where subject to mechanical damage shall be installed in UL-Listed raceway or conduit.
- G. Class 2 wiring shall not be installed in raceways or conduit containing Class 1 wiring. Junction boxes, enclosures, and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays, transformers, CTs, etc.). Refer to the requirements of the applicable code enforcing authorities and AHJ.
 - 1. NEC Chapter 7 Article 725 – Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
 - 2. CSA C22.1-12 Rule 16-212 Separation of Class 2 circuit conductors from other circuits
- H. Sizing and selection of raceways, enclosures and conduit shall be the responsibility of the Contractor in keeping with the manufacturer's recommendations and the requirements of NEC, CSA C22.1-12, the Electrical System Specifications and any/all applicable local codes and/or AHJ.
 - 1. Conceal all raceways and conduit, except within mechanical, electrical, or service spaces.
 - 2. Install raceways and conduit to maintain a minimum clearance of 15 cm (6") from high-temperature equipment (e.g., steam lines, flues, etc.).
 - 3. Secure and support raceways and conduit to the structure per the manufacturer's recommendations. Raceways and conduit may not be hung on flexible straps or tie rods, nor may they be attached to ductwork.

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4. Comply with the requirements of the Electrical System Specifications when raceways or conduit crosses building expansion joints.
5. Include a minimum of one (1) pull string in each raceway or conduit with a minimum diameter of 2.5 cm (1").
- I. Flexible metal raceways, liquid-tight, and other non-rigid conduit shall not exceed 1 m (3') in length and shall be mechanically supported at each end.
 1. Flexible metal raceways, liquid-tight, and other non-rigid conduit smaller than 12 mm (0.5") shall not be used.
- J. Wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be made at a terminal block.
 1. Wire-to-wire connections shall be made in enclosures or approved junction boxes with a maximum fill of 50%.
- K. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- L. Use color-coded conductors consistently throughout the entire System installation.
- M. Maximum allowable voltage for control wiring shall be 120 volts.
- N. The System Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the project site.
- O. Maximum pulling, tension, and bend radius for cable installation as specified by the manufacturer shall not be exceeded during installation.
- P. The Contractor shall verify integrity of all wiring to ensure continuity and freedom from shorts and grounds after the installation is complete.
- Q. When any cable enters or exits the building a lightning arrestor must be installed between the conductors and ground. The lightning arrestor shall be installed according to the manufacturer's recommendations.

3.23 COMMUNICATION WIRING

- A. Communication and network wiring shall adhere to the Wiring article in Part 3 of this specification and the manufacturer's recommendations.
- B. Communication wiring shall not be installed in any raceway or conduit with Class 1 or Class 2 wiring.
- C. All communication wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- D. All communication cabling shall be labelled to indicate origination and destination devices.
- E. All communications shielding shall be grounded as per manufacturer's recommendations and in accordance with the NEC/CSA (as applicable).

3.24 EXISTING EQUIPMENT

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- A. Wiring. The System Contractor may reuse any abandoned cables that comply with the minimum construction, quality, and performance requirements of this specification. The integrity of all wire and its proper application to the installation are the responsibility of the Contractor. The wire shall be properly identified and tested in accordance with this specification. Unused or redundant wiring must be properly identified as such.
 - 1. All interconnecting control cabling that is not compliant with this specification shall be removed and become the property of the Owner or shall become the property of the Contractor at the discretion of the Owner.
- B. Local Control Panels. The Contractor may reuse existing local control panels that comply with the minimum construction, quality, and performance requirements of this specification to house new equipment. All redundant equipment within these panels must be removed. Panel face cover must be patched to fill all holes caused by removal of unused equipment or replaced with new.
 - 1. Per the contract documents, existing local control panels and devices marked for demolition shall be removed and delivered to the Owner or shall become the property of the Contractor at the discretion of the Owner.
 - 2. Per the contract documents, existing local control panels and devices marked for relocation shall be salvaged, reconditioned, and reused as noted. Relocate as shown.
 - 3. Unless expressly directed in the contract documentation, the Contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the Contractor find existing equipment that requires maintenance, the Engineer and/or Construction Management team is to be notified immediately.
 - 4. Temperature Sensor Wells. The Contractor may reuse appropriate existing wells in piping for temperature sensors. These wells shall be modified as required for proper fit of new sensors.
 - 5. Indicator Gages. Where these devices remain, and are not removed, they must be made operational and recalibrated to ensure accuracy in compliance with the requirements of this specification. Maintain the operation of existing pneumatic transmitters and gages. Should the Contractor find existing equipment that requires maintenance, the Engineer and/or Construction Management team is to be notified immediately.
 - 6. Room Thermostats. Unless specifically noted otherwise, remove and deliver to the Owner.
 - 7. Electronic Sensors and Transmitters. Unless specifically noted otherwise, remove and deliver to the Owner.
 - 8. Controllers and Auxiliary Electronic Devices. Unless specifically noted otherwise, remove and deliver to the Owner.
 - 9. Pneumatic Controllers, Relays and Gages. Unless specifically noted otherwise, remove and deliver to the Owner.

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10. Damper Actuators, Linkages, and Appurtenances. Unless specifically noted otherwise, remove and deliver to the Owner.
11. Control Valves. Unless specifically noted otherwise, remove and deliver to the Owner.
12. Control Compressed Air System. Unless specifically noted otherwise, remove and deliver to the Owner.
13. Unless specifically noted otherwise, the mechanical system must remain in operation during the normal occupied hours of operation for the facility. No modifications to the system shall cause the mechanical system to be shut down for more than 15 minutes or to fail to maintain space comfort conditions during any such period. Perform cut-over of controls that cannot meet these conditions outside of those hours.
14. The scheduling of fans through existing or temporary time clocks or BAS shall be maintained throughout the System installation.
15. Modify existing starter control circuits, if necessary, to provide Hand/Off/Auto control of each starter controlled. If new starters or starter control packages are required, these shall be included as part of this contract.
16. Patch holes and finish to match existing walls.

3.25 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels, shall be labelled at each end within 5 cm (2") of the termination with the BACnet object instance or termination number.
- B. Manufacturer's name plates and UL or CSA labels are to be visible and legible after equipment is installed.
- C. All labels and identifiers shall match record documents.

3.26 SYSTEM CHECK-OUT AND TESTING

- A. All testing listed in this article shall be performed by the Contractor. This testing shall be completed before system demonstration is initiated.
 1. The Contractor shall furnish all the necessary labor and test and calibration apparatus required to calibrate and prepare for service all instruments, controls, and accessory equipment provided under this specification.
 2. Verify that all control terminations are tight, and all control wiring is proper and free from shorts and faults.
 3. Enable normal operational control and verify calibration of all input devices individually according to manufacturer's recommendations.
 4. Verify the operation of all output devices including action, normal positions, fail-safe positions, start and span, and travel.
 5. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation.

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- a. Tune all control loops and optimum start/stop routines.
 - b. Check each alarm separately by providing an appropriate signal to trip the alarm.
 - c. Trip all safeties and interlocks to verify proper operation and fail-safe response.
- B. As each device is tested, a log shall be completed showing the date, technician's initials, and any corrective action taken as a result of operational failures. This log shall be submitted prior to scheduling acceptance demonstration and for inclusion in the final O&M manuals.

3.27 CONTROL ACCEPTANCE AND DEMONSTRATION

- A. Prior to acceptance, the System shall undergo a series of performance tests to verify proper operation and compliance with this specification.
- B. The tests described in this section are in addition, and subsequent, to the tests necessary for start-up, tuning, debugging, and compliance with the requirements of the Check-out and Testing section of this specification. The Engineer or an appointed representative shall be present at the tests specified in this section and shall be notified ten (10) working days prior to the testing procedures.
- C. The Contractor shall provide at least two (2) qualified technical personnel equipped with means for two-way communication to demonstrate the actual operation of all control operations and modes including occupied, unoccupied, seasonal changeover, and emergency/fail-safe operation.
 - 1. Compliance with this specification shall be demonstrated including all specification sections, schedules, drawings, and Sequences of Operation.
- D. Demonstrate operator interface compliance with the requirements of the specification.
- E. Additionally, the following shall be demonstrated:
 - 1. Control loop response shall be proven in the form of trend data in a graphical format displaying the actual response to process variables of each control loop.
 - a. Trends shall include the process variable, setpoint, loop output, and physical output position.
 - b. Trends shall show the loop's response to a change in setpoint which represents a change in output equal to at least 25% of its full range.
 - c. The sampling rate shall be between 10 seconds and 3 minutes.
 - d. Leading or following loops shall be required to be tuned by the Contractor.
 - 2. Operational logs for each system that demonstrate normal operation.
 - a. Trends shall include the process variable, setpoint, loop output, physical output position, operational mode, and equipment status.

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- b. Trends shall cover three (3) 48-hour periods with a sampling interval of not more than 10 minutes.
- 3. At the discretion of the Owner/Engineer trends from a random sampling of 25% of unitary controllers/applications shall be submitted.
- 4. Database backup of the entire network and database restoration for selected controllers.
- F. As each device is tested, a log shall be completed showing the date, technician's initials, and any corrective action taken as a result of operational failures.
- G. The Contractor shall display, using a third-party data packet analytical tool, that all System data transmission, including operator interface requests, are being performed using BACnet.
- H. Any tests that fail to demonstrate the operational compliance of the System shall be repeated, at a later date, after the issues have been resolved. The System Contractor shall be responsible for any necessary repairs or revisions to successfully complete all tests.
- I. Within seven (7) calendar days of successful completion of the tests and documentation described herein the System shall be accepted as complete.
 - 1. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be performed at the discretion of the Owner after acceptance and as a part of the warranty period.

3.28 CLEANING

- A. The Contractor shall clean and remove all debris resulting from his/her activities daily. The Contractor shall remove all cartons, containers, crates, etc. under his/her control as soon as their contents have been removed.
- B. At the completion of work in any area the Contractor shall clean all work, equipment, etc. keeping it free from dust, dirt, debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any other factory finish damage shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed or damaged shall be replaced with new material and painted to match the adjacent areas.

3.29 TRAINING

- A. The Contractor shall provide instruction on the adjustment, operation and maintenance of the System including all hardware and software provided and installed in compliance with the requirements of this specification.
 - 1. Training shall be performed by a manufacturer's representative and/or instructor or a manufacturer-trained application engineer and/or technician with a minimum of 5-years of experience in the installation, programming and operation of the System.
 - 2. All training equipment and material shall be provided by this Contractor.

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- B. Training in the operation of the System shall be performed utilizing a BACnet network of working controllers representative of the installed network and/or the Owner's facility and shall include:
 - 1. Overview of the installed system and network architecture.
 - 2. System components.
 - 3. Graphical User Interface (GUI) operation.
 - 4. Day-to-day operations including modification of system setpoints, schedules, calendars, manual overrides, trending, log retrieval, alarm handling, etc.
 - 5. Software operation, including navigating the workstation displays, database management, troubleshooting, diagnostics, report generation, etc.
 - 6. Database design and modification including adding objects, modifying routines, optimizing operation, etc.
 - 7. General operation of the workstation hardware and peripherals.
- C. Training videos that describe the operation of the System shall be provided, and/or made accessible, to the Owner.
- D. On-site walk-through shall cover the deployment and execution of the complete System and components including:
 - 1. Sequences of Operation.
 - 2. Location of all panels, enclosures, controllers, devices, sensors, etc. and equipment and panel lay-out.
 - 3. Hardware preventive maintenance, calibration, troubleshooting, maintenance, and repair.
 - 4. Proper use of service tools and materials.

3.30 INSTRUCTIONS TO OTHER CONTRACTORS

- A. Control Valve Installation. Control valves shall be installed in accordance with the manufacturer's recommendations and in compliance with this specification.
 - 1. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal positions.
 - 2. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
 - 3. Isolation valves shall be installed so that the control valve body may be serviced without draining the piping system. Unions or flanges shall be provided at all connections to control valves.
 - 4. Provide tags for all controls valves indicating service and identifier. Secure tags with chain and hook. Identifiers shall match approved control shop drawings.

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- B. Control Damper Installation. Control dampers shall be installed in accordance with the manufacturer's recommendations and in compliance with this specification.
1. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
 2. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Inside clear duct openings shall measure 6 mm (1/4") larger than damper actual outside clear dimensions and shall be square, straight, and level.
 3. Individual damper sections as well as entire multiple section assemblies must be completely square and free from racking, twisting, or binding. Diagonal measurements from upper corners to opposite lower corners must be within 3 mm (1/8") of one another.
 4. Unless specifically designed for vertical blade orientation, dampers must be installed with blade axis horizontal.
 5. Damper blades, shafts, and linkages must operate without binding. On multiple section assemblies, blades must open and close simultaneously.
 6. Provide a visible and accessible indication of damper position on the drive shaft end.
 7. Support ductwork in area of damper when required to prevent sagging due to damper weight.
 8. After installation caulk between frame and duct and/or opening to prevent leakage around perimeter of damper.

END OF PART 3

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SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1. DESCRIPTION

A. Water piping to connect HVAC equipment, including the following:

B. Chilled water, heating hot water piping.

2. RELATED WORK

A. General Conditions, Mechanical, Structural, Electrical and Commissioning requirements outlined in these contract documents relate to this equipment specification.

B. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one year old.

3. SUBMITTALS

A. Submit in accordance with SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Manufacturer's Literature and Data:

1. Pipe and equipment supports. Submit calculations for variable spring and constant support hangers.

2. Pipe and tubing, with specification, class or type, and schedule.

3. Pipe fittings, including miscellaneous adapters and special fittings.

4. Flanges, gaskets and bolting, including link seals.

5. Valves of all types.

6. All hydronic system components, including separators, expansion tanks, strainers, flexible connectors, expansion compensators, flow meters and sensors, gauges and test wells.

7. Seismic bracing details if required by building category and class.

C. Submit the welder's qualifications in the form of a current (less than one year old) and formal certificate.

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- D. Coordination Drawings: Submit scale drawings.
- E. AsBuilt Piping Diagrams: Provide drawings as follows for chilled water, and heating hot water system. Provide plan and profile drawings showing installed utilities and dimensioned curb crossings, nearby utilities crossing and in the same trench.

1. One complete set of reproducible drawings.
2. One complete set of drawings in electronic Autocad and pdf format.

4. APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. American National Standards Institute, Inc.

B. American Society of Mechanical Engineers/American National Standards Institute, Inc.
(ASME/ANSI):

B1.20.1-83(R2006)	Pipe Threads, General Purpose (Inch)
B16.406	Gray Iron Threaded Fittings B16.18-01 Cast Copper Alloy
Solder joint Pressure fittings	

C. American National Standards Institute, Inc./Fluid Controls Institute (ANSI/FCI):

70-2-2006	Control Valve Seat Leakage
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D. American Society of Mechanical Engineers (ASME):

B16.1-98	Cast Iron Pipe Flanges and Flanged Fittings
B16.3-2006	Malleable Iron Threaded Fittings: Class 150 and 300
B16.42006	Gray Iron Threaded Fittings: (Class 125 and 250)
B16.5-2003	Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24
Metric/Inch Standard	
B16.9-07	Factory Made Wrought Butt Welding Fittings
B16.11-05	Forged Fittings, Socket Welding and Threaded
B16.3906	Malleable Iron Threaded Pipe Unions
B16.42-06	Ductile Iron Pipe Flanges and Flanged Fittings

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E. American Society for Testing and Materials (ASTM):

A47/A47M-99 (2004)	Ferritic Malleable Iron Castings
A53/A53M-07	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A106/A106M-08	Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service
A12604	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
A18303	Standard Specification for Carbon Steel Track Bolts and Nuts
A216/A216M-08	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
A234/A234M-07	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
A30707	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
A53684 (2004)	Standard Specification for Ductile Iron Castings
A615/A615M-08	Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
A653/A 653M-08	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) By the Hot-Dip Process
B3208	Standard Specification for Solder Metal
C478-09	Precast Reinforced Concrete Manhole Sections
D3350-08	Polyethylene Plastics Pipe and Fittings Materials
C591-08	Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
D1784-08	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compound

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D1785-06 Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120

D2241-05 Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)

F477-08 Elastomeric Seals Gaskets) for Joining Plastic Pipe

F. American Water Works Association (AWWA):

C110-08 Ductile Iron and Grey Iron Fittings for Water

C203-02 Coal Tar Protective Coatings and Linings for Steel Water Pipe
Lines Enamel and Tape Hot Applied

G. American Welding Society (AWS):

B2.1-02 Standard Welding Procedure Specification

H. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:

SP-6702a Butterfly Valves

SP-7006 Gray Iron Gate Valves, Flanged and Threaded Ends

SP-7105 Gray Iron Swing Check Valves, Flanged and Threaded Ends

SP-8008 Bronze Gate, Globe, Angle and Check Valves

SP-8502 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends

SP-11096 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved
and Flared Ends

SP-12500 Gray Iron and Ductile Iron In-line, Spring Loaded, Center-Guided
Check Valves

5. SPARE PARTS

A. For mechanical pressed sealed fittings provide tools required for each pipe size used at the facility.

PART 2 PRODUCTS

1. PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES

A. Provide in accordance with COMMON WORK RESULTS FOR HVAC.

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2. PIPE AND TUBING

A. Chilled Water, Condenser Water, Heating Hot Water, and Glycol Water and Vent Piping:

1. Steel: ASTM A53 Grade B, seamless or ERW, Schedule 40.
2. Copper water tube option: ASTM B88, Type K or L, hard drawn. Soft drawn tubing, 3/4 inch and larger, may be used for runouts routed under slab to floor mounted fan coil units.

B. Extension of Domestic Water Make-up Piping: ASTM B88, Type K or L, hard drawn copper tubing.

C. Cooling Coil Condensate Drain Piping:

1. From air handling units: Copper water tube, ASTM B88, Type M, or schedule 40 PVC plastic piping.
2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L for runouts and Type M for mains.

D. Chemical Feed Piping for Condenser Water Treatment: Chlorinated polyvinyl chloride (CPVC), Schedule 80, ASTM F441.

E. Pipe supports, including insulation shields, for above ground piping: COMMON WORK RESULTS FOR HVAC.

3. FITTINGS FOR STEEL PIPE

A. 2 inches and Smaller: Screwed or welded joints.

1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
2. Forged steel, socket welding or threaded: ASME B16.11.
3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
4. Unions: ASME B16.39.

B. Water hose connection adapter: Brass, pipe thread to 3/4 inch garden hose thread, with hose cap nut.

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C. 21/2 inches and Larger: Welded or flanged joints. Contractor's option: Grooved mechanical couplings and fittings are optional.

1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.

2. Welding flanges and bolting: ASME B16.5:

a. Water service: Weld neck or slipon, plain face, with 1/8 inch thick full face neoprene gasket suitable for 220 degrees F.

b. Contractor's option: Convuluted, cold formed 150 pound steel flanges, with teflon gaskets, may be used for water service.

c. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

D. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel halfcouplings, ASME B16.11 may be used for drain, vent and gage connections.

E. Grooved Mechanical Pipe Couplings and Fittings (Contractor's Option): Grooved Mechanical Pipe Couplings and Fittings may be used, with cut or roll grooved pipe, in water service up to 230 degrees F in lieu of welded, screwed or flanged connections. All joints must be rigid type.

1. Grooved mechanical couplings: Malleable iron, ASTM A47 or ductile iron, ASTM A536, fabricated in two or more parts, securely held together by two or more trackhead, square, or ovalneck bolts, ASTM A449 and A183.

2. Gaskets: Rubber product recommended by the coupling manufacturer for the intended service.

3. Grooved end fittings: Malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A53 or A106, designed to accept grooved mechanical couplings. Tapin type branch connections are acceptable.

4. FITTINGS FOR COPPER TUBING

A. Joints:

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1. Solder Joints: Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
2. Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.
- B. Bronze Flanges and Flanged Fittings: ASME B16.24.
- C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.
5. DIELECTRIC FITTINGS
 - A. Provide where copper tubing and ferrous metal pipe are joined.
 - B. 2 inches and Smaller: Threaded dielectric union, ASME B16.39.
 - C. 2 1/2 inches and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.
 - D. Temperature Rating, 210 degrees F.
 - E. Contractor's option: On pipe sizes 2" and smaller, screwed end brass ball valves or dielectric nipples may be used in lieu of dielectric unions.
6. SCREWED JOINTS
 - A. Pipe Thread: ANSI B1.20.
 - B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.
7. VALVES
 - A. Asbestos packing is not acceptable.
 - B. All valves of the same type shall be products of a single manufacturer.
 - C. Provide chain operators for valves 6 inches and larger when the centerline is located 8 feet or more above the floor or operating platform.

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D. Shut-Off Valves

1. Ball Valves (Pipe sizes 2" and smaller): MSS-SP 110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 400 psig working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.

2. Butterfly Valves (Pipe Sizes 2-1/2" and larger): Provide stem extension to allow 2 inches of pipe insulation without interfering with valve operation. MSSSP 67, flange lug type or grooved end rated 175 psig working pressure at 200 degrees F. Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated pressure. Not permitted for direct buried pipe applications.

a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 654512 electro-plated.

b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.

c. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.

1) Valves 6 inches and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.

2) Valves 8 inches and larger: Enclosed worm gear with handwheel, and where required, chainwheel operator.

3) Gate Valves (Contractor's Option in lieu of Ball or Butterfly Valves):

4) 2 inches and smaller: MSSSP 80, Bronze, 150psig, wedge disc, rising stem, union bonnet.

5) 2 1/2 inches and larger: Flanged, outside screw and yoke. MSSSP 70, iron body, bronze mounted, 125 psig wedge disc.

E. Globe and Angle Valves

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1. Globe Valves

a. 2 inches and smaller: MSSSP 80, bronze, 150 lb. Globe valves shall be union bonnet with metal plug type disc.

b. 2 1/2 inches and larger: 125 psig, flanged, iron body, bronze trim, MSSSP85 for globe valves.

2. Angle Valves:

a. 2 inches and smaller: MSSSP 80, bronze, 150 lb. Angle valves shall be union bonnet with metal plug type disc.

b. 2 1/2 inches and larger: 125 psig, flanged, iron body, bronze trim, MSSSP85 for angle.

F. Check Valves

1. Swing Check Valves:

a. 2 inches and smaller: MSSSP 80, bronze, 150 lb., 45 degree swing disc.

b. 2 1/2 inches and larger: 861 kPa 125 psig, flanged, iron body, bronze trim, MSSSP71 for check valves.

G. Water Flow Balancing Valves: For flow regulation and shutoff. Valves shall be line size rather than reduced to control valve size.

1. Ball or Globe style valve.

2. A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.

3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.

H. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control.

Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:

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1. Gray iron (ASTM A126) or brass body rated 175 psig at 200 degrees F, with stainless steel piston and spring.
 2. Brass or ferrous body designed for 300 psig service at 250 degrees F, with corrosion resistant, tamper proof, selfcleaning piston/spring assembly that is easily removable for inspection or replacement.
 3. Combination assemblies containing ball type shutoff valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.
 4. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.
8. WATER FLOW MEASURING DEVICES
- A. Minimum overall accuracy plus or minus three percent over a range of 70 to 110 percent of design flow. Select devices for not less than 110 percent of design flow rate.
 - B. Venturi Type: Bronze, steel, or cast iron with bronze throat, with valved pressure sensing taps upstream and at the throat.
 - C. Wafer Type Circuit Sensor: Cast iron wafertype flow meter equipped with readout valves to facilitate the connecting of a differential pressure meter. Each readout valve shall be fitted with an integral check valve designed to minimize system fluid loss during the monitoring process.
 - D. SelfAveraging Annular Sensor Type: Brass or stainless steel metering tube, shutoff valves and quickcoupling pressure connections. Metering tube shall be rotatable so all sensing ports may be pointed downstream when unit is not in use.
 - E. Insertion Turbine Type Sensor: DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
 - F. Flow Measuring Device Identification:
 1. Metal tag attached by chain to the device.
 2. Include meter or equipment number, manufacturer's name, meter model, flow rate factor and design flow rate in gpm.

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9. STRAINERS

A. Y Type.

1. Screens: Bronze, monel metal or 188 stainless steel, free area not less than 2 1/2 times pipe area, with perforations as follows: 0.045 inch diameter perforations for 4 inches and larger: 0.125 inch diameter perforations.

B. Suction Diffusers: Specified in HYDRONIC PUMPS.

10. FLEXIBLE CONNECTORS FOR WATER SERVICE

A. Flanged Spool Connector:

1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.

2. Working pressures and temperatures shall be 140 psig at 250 deg F, minimum rating:

3. Provide ductile iron retaining rings and control units.

11. EXPANSION JOINTS

A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.

B. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.

C. Expansion Compensators:

1. Corrugated bellows, externally pressurized, stainless steel or bronze.

2. Internal guides and antitorque devices.

3. Threaded ends.

4. External shroud.

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5. Conform to standards of EJMA.

D. Expansion Joint Identification: Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

12. HYDRONIC SYSTEM COMPONENTS

A. Air Purger: Cast iron or fabricated steel, 125 psig water working pressure, for inline installation.

B. Tangential Air Separator: ASME Pressure Vessel Code construction for 125 psig working pressure, flanged tangential inlet and outlet connection, internal perforated stainless steel air collector tube designed to direct released air into expansion tank, bottom blowdown connection. If scheduled on the drawings, provide a removable stainless steel strainer element having 3/16 inch perforations and free area of not less than five times the crosssectional area of connecting piping.

C. Diaphragm Type PrePressurized Expansion Tank: ASME Pressure Vessel Code construction for 125 psig working pressure, welded steel shell, rustproof coated, with a flexible elastomeric diaphragm suitable for a maximum operating temperature of 240 degrees F. Tank shall be equipped with system connection, drain connection, standard air fill valve and be factory precharged to a minimum of 12 psig.

D. Pressure Reducing Valve (Water): Diaphragm or bellows operated, spring loaded type, with minimum adjustable range of 4 psig above and below set point. Bronze, brass or iron body and bronze, brass or stainless steel trim, rated 125 psig working pressure at 225 degrees F.

E. Pressure Relief Valve: Bronze or iron body and bronze or stainless steel trim, with testing lever. Comply with ASME Code for Pressure Vessels, Section 8, and bear ASME stamp.

F. Automatic Air Vent Valves (where shown): Cast iron or semisteel body, 150 psig working pressure, stainless steel float, valve, valve seat and mechanism, minimum 1/2 inch water connection and 1/4 inch air outlet. Air outlet shall be piped to the nearest floor drain.

13. WATER FILTERS AND POT CHEMICAL FEEDERS

1. See section HVAC WATER TREATMENT, Article 2.2, CHEMICAL

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2. TREATMENT FOR CLOSED LOOP SYSTEMS.

14. GAGES, PRESSURE AND COMPOUND

A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound for air, oil or water), initial midscale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 4 1/2 inches in diameter, 1/4 inch NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.

B. Provide brass lever handle union cock. Provide brass/bronze pressure snubber for gages in water service.

C. Range of Gages: Provide range equal to at least 130 percent of normal operating range.

1. For condenser water suction (compound): Minus 30 inches Hg to plus 100 psig.

15. PRESSURE/TEMPERATURE TEST PROVISIONS

A. Pete's Plug: 1/4 inch MPT by 3 inches long, brass body and cap, with retained safety cap, norel selfclosing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.

16. THERMOMETERS

A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 6 inch brass stem, straight, fixed or adjustable angle as required for each in reading.

B. Case: Chrome plated brass or aluminum with enamel finish.

C. Scale: Not less than 9 inches, range as described below, two degree graduations.

D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.

E. Scale ranges:

1. Chilled Water and Glycol-Water: 32-100 degrees F.

2. Hot Water and Glycol-Water: 30-240 degrees F.

17. ELECTRICAL HEAT TRACING SYSTEMS

A. Systems shall meet requirements of the National Electrical Code (NEC), Section 427.

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B. Provide tracing for outdoor piping subject to freezing temperatures (Below 38 degrees F) as follows:

1. Condenser water piping for cooling tower.
2. Make-up water.
3. Chilled water, hot water, and all other areas exposed to the weather.
4. Domestic water lines exposed to weather.

C. Heat tracing shall be provided to the extent shown on the drawings (Floor plans and Elevations).

Heat tracing shall extend below grade to below the defined frost line.

D. Heating Cable: Flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cuttolength at the job site and for wrapping around valves and complex fittings. Self-regulation shall prevent overheating and burnouts even where the cable overlaps itself.

1. Provide end seals at ends of circuits. Wire at the ends of the circuits is not to be tied together.
2. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at 2.2 degrees C (36 degrees F) minimum during winter outdoor design temperature, but not less than the following:

- a. 3 inch pipe and smaller with 1 inch thick insulation: 4 watts per foot of pipe.
- b. 4 inch pipe and larger 1 1/2 inch thick insulation: 8 watts per foot of pipe.

E. Electrical Heating Tracing Accessories:

1. Power supply connection fitting and stainless steel mounting brackets. Provide stainless steel worm gear clamp to fasten bracket to pipe.
2. 1/2 inch wide fiberglass reinforced pressure sensitive cloth tape to fasten cable to pipe at 12 inch intervals.
3. Pipe surface temperature control thermostat: Cast aluminum, NEMA 4 (watertight) enclosure, 1/2 inch NPT conduit hub, SPST switch rated 20 amps, with capillary and copper bulb sensor. Set thermostat to maintain pipe surface temperature at not less than 34 degrees F.

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4. Signs: Manufacturer's standard (NEC Code), stamped "ELECTRIC TRACED" located on the insulation jacket at 10 feet intervals along the pipe on alternating sides.

PART 3 - EXECUTION

1. GENERAL

- A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- C. Support piping securely. Refer to PART 3, COMMON WORK RESULTS FOR HVAC.
- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide one inch minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than one inch in 40 feet. Provide eccentric reducers to keep bottom of sloped piping flat.
- E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
- F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line takeoffs with 3elbow swing joints where noted on the drawings.

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G. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.

H. Provide manual or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.

I. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:

1. Water treatment pot feeders and condenser water treatment systems.
2. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.

J. Thermometer Wells: In pipes 2 1/2 inches and smaller increase the pipe size to provide free area equal to the upstream pipe area.

K. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material.

L. Where copper piping is connected to steel piping, provide dielectric connections.

2. PIPE JOINTS

A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in COMMON WORK RESULTS FOR HVAC.

B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.

C. Mechanical Joint: Pipe grooving shall be in accordance with joint manufacturer's specifications. Lubricate gasket exterior including lips, pipe ends and housing interiors to prevent pinching the gasket during installation. Lubricant shall be as recommended by coupling manufacturer.

D. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

E. Solvent Welded Joints: As recommended by the manufacturer.

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3. SEISMIC BRACING ABOVEGROUND PIPING

1. Provide as required by IBC for project Category and Class and in accordance with structural specifications and ASCE 7.

4. LEAK TESTING ABOVEGROUND PIPING

A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. Tests may be either of those below, or a combination, as approved by the Resident Engineer.

B. An operating test at design pressure, and for hot systems, design maximum temperature.

C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

5. FLUSHING AND CLEANING PIPING SYSTEMS

A. Water Piping: Clean systems as recommended by the water treatment subcontractor, using submitted and approved chemicals.

1. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hideout areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 6 feet per second, if possible. Connect deadend supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect downstream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps.

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2. Cleaning: Using submitted and approved products, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where deadend debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than four hours. Blowdown all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.

3. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean makeup. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

6. WATER TREATMENT

- A. Install water treatment equipment and provide water treatment system piping.
- B. Close and fill system as soon as possible after final flushing to minimize corrosion.
- C. Charge systems with submitted and approved.

7. ELECTRIC HEAT TRACING

- A. Install tracing as recommended by the manufacturer.
- B. Coordinate electrical connections.

8. OPERATING AND PERFORMANCE TEST AND INSTRUCTION

- A. Refer to PART 3 COMMON WORK RESULTS FOR HVAC.
- B. Adjust red set hand on pressure gages to normal working pressure.

End of Section

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SECTION 23 23 00 REFRIGERANT PIPING

PART 1 GENERAL

1 DESCRIPTION

A. Field refrigerant piping for direct expansion HVAC systems, including site-erected coolers and freezers. This section shall govern installation of refrigerant piping systems installed per the manufacturer's direction and instruction, it is not intended to supersede any installation direction given by the manufacturer. In the event of conflict, the contractor shall submit an RFI requesting clarification. The contractor's price shall include a complete and functioning system installation per the manufacturer's Installation Directions, including any long length, high riser, or other special condition.

B. Refrigerant piping shall be sized, selected, and designed either by the equipment manufacturer or in strict accordance with the manufacturer's published instructions. The schematic piping diagram shall show all accessories such as, stop valves, level indicators, liquid receivers, oil separator, gauges, thermostatic expansion valves, solenoid valves, moisture separators and driers to make a complete installation.

C. Definitions:

1. Refrigerating system: Combination of interconnected refrigerant-containing parts constituting one closed refrigeration circuit in which a refrigerant is circulated for the purpose of extracting heat.

a. Low side means the parts of a refrigerating system subjected to evaporator pressure.

b. High side means the parts of a refrigerating system subjected to condenser pressure.

2. Brazed joint: A gastight joint obtained by the joining of metal parts with alloys which melt at temperatures higher than 449 degrees C (840 degrees F) but less than the melting temperatures of the joined parts.

2. RELATED WORK

A. Drawings and Specifications as issued as a complete design document apply, including specification sections for Common Work Results for Plumbing and HVAC.

3. QUALITY ASSURANCE

A. Refer to specification section COMMON WORK RESULTS FOR HVAC.

B. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.

C. Comply with ASME B31.5: Refrigerant Piping and Heat Transfer Components.

D. Products shall comply with UL 207 "Refrigerant-Containing Components and Accessories, "Nonelectrical"; or UL 429 "Electrical Operated Valves."

4. SUBMITTALS

A. Submit components and certifications as outlined in the Project General Requirements specifications for review and approval.

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B. Shop Drawings:

1. Complete information for components noted, including valves and refrigerant piping accessories, clearly presented, shall be included to determine compliance with drawings and specifications for all components required. Components are listed but not limited to:
 - a. Tubing and fittings
 - b. Valves
 - c. Strainers
 - d. Moistureliquid indicators
 - e. Filterdriers
 - f. Flexible metal hose
 - g. Liquidsuction interchanges
 - h. Oil separators (when specified)
 - i. Gages
 - j. Pipe and equipment supports
 - k. Refrigerant and oil
 - l. Pipe/conduit roof penetration cover
 - m. Soldering and brazing materials
 2. Layout of refrigerant piping and accessories, including flow capacities, valves locations, and oil traps slopes of horizontal runs, floor/wall penetrations, and equipment connection details.
- C. Certification: Copies of certificates for welding procedure, performance qualification record and list of welders' names and symbols.

D. Design Manual: Furnish two copies of design manual of refrigerant valves and accessories.

5. APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. Air Conditioning, Heating, and Refrigeration Institute (ARI/AHRI):

495-1999 (R2002)	Standard for Refrigerant Liquid Receivers
730-2005	Flow Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers
750-2007	Thermostatic Refrigerant Expansion Valves
7602007	Performance Rating of Solenoid Valves for Use with Volatile Refrigerants

C. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE):

ANSI/ASHRAE 152007	Safety Standard for Refrigeration Systems (ANSI)
ANSI/ASHRAE 172008	Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves (ANSI)

63.1-95 (RA 01) Method of Testing Liquid Line Refrigerant Driers (ANSI)

D. American National Standards Institute (ANSI):

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- ASME (ANSI)A13.1-2007 Scheme for Identification of Piping Systems
Z535.1-2006 Safety Color Code
- E. American Society of Mechanical Engineers (ASME):
ANSI/ASME B16.222001 (R2005)
Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings (ANSI)
ANSI/ASME B16.242006 Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300,
400, 600, 900, 1500 and 2500 (ANSI)
ANSI/ASME B31.5-2006 Refrigeration Piping and Heat Transfer Components (ANSI)
ANSI/ASME B40.100-2005 Pressure Gauges and Gauge Attachments
ANSI/ASME B40.200-2008 Thermometers, Direct Reading and Remote Reading
- F. American Society for Testing and Materials (ASTM)
A126-04 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe
FittingsB3208 Standard Specification for Solder Metal
B8803 Standard Specification for Seamless Copper Water Tube
B88M-05 Standard Specification for Seamless Copper Water Tube (Metric)
B28008 Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration
Field Service
- G. American Welding Society, Inc. (AWS):
Brazing Handbook
A5.8/A5.8M04 Standard Specification for Filler Metals for Brazing and Braze Welding
- H. Underwriters Laboratories (U.L.):
U.L.207-2009 Standard for Refrigerant-Containing Components and Accessories, Nonelectrical
U.L.429-99 (Rev.2006) Standard for Electrically Operated Valves

PART 2 PRODUCTS

1. PIPING AND FITTINGS

- A. Refrigerant Piping: For piping up to 4 inch use Copper refrigerant tube, ASTM B280, cleaned, dehydrated and sealed, marked ACR on hard temper straight lengths. Coils shall be tagged ASTM B280 by the manufacturer.
- B. Water and Drain Piping: Copper water tube, ASTM B88, Type M or L. Optional drain piping material where approved by the engineer, architect and local authority: Schedule 80 flame retardant Polypropylene plastic.
- C. Fittings, Valves and Accessories:
1. Copper fittings: Wrought copper fittings, ASME B16.22.

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- a. Braze Joints, refrigerant tubing: Cadmium free, AWS A5.8/A5.8M, 45 percent silver brazing alloy, Class BAg-5.
- b. Solder Joints, water and drain: 955 tinantimony, ASTM B32 (95TA).
2. Steel fittings: ASTM wrought steel fittings.
- a. Refrigerant piping – Welded Joints.
3. Flanges and flanged fittings: ASME B16.24.
4. Refrigeration Valves:
 - a. Stop Valves: Brass or bronze alloy, packless, or packed type with gas tight cap, frost proof, back seating.
 - b. Pressure Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; UL listed. Forged brass with nonferrous, corrosion resistant internal working parts of high strength, cast iron bodies conforming to ASTM A126, Grade B. Set valves in accordance with ASHRAE Standard 15.
 - c. Solenoid Valves: Comply with ARI 760 and UL 429, UL-listed, two-position, direct acting or pilot-operated, moisture and vaporproof type of corrosion resisting materials, designed for intended service, and solder-end connections. Fitted with suitable NEMA 250 enclosure of type required by location and normally // open // closed // holding coil.
 - d. Thermostatic Expansion Valves: Comply with ARI 750. Brass body with stainless-steel or non-corrosive non ferrous internal parts, diaphragm and spring-loaded (direct-operated) type with sensing bulb and distributor having side connection for hot-gas bypass and external equalizer. Size and operating characteristics as recommended by manufacturer of evaporator and factory set for superheat requirements. Solder-end connections. Testing and rating in accordance with ASHRAE Standard 17.
 - e. Check Valves: Brass or bronze alloy with swing or lift type, with tight closing resilient seals for silent operation; designed for low pressure drop, and with solder-end connections. Direction of flow shall be legibly and permanently indicated on the valve body.
5. Strainers: Designed to permit removing screen without removing strainer from piping system, and provided with screens 80 to 100 mesh in liquid lines NPS 1 and smaller, 60 mesh in liquid lines larger than NPS 1, and 40 mesh in suction lines. Provide strainers in liquid line serving each thermostatic expansion valve, and in suction line serving each refrigerant compressor not equipped with integral strainer.
6. Refrigerant Moisture/Liquid Indicators: Doubleported type having heavy sight glasses sealed into forged bronze body and incorporating means of indicating refrigerant charge and moisture indication. Provide screwed brass seal caps.
7. Refrigerant FilterDryers: UL listed, angle or inline type, as shown on drawings. Conform to ARI Standard 730 and ASHRAE Standard 63.1. Heavy gage steel shell protected with corrosion-resistant paint; perforated baffle plates to prevent desiccant bypass. Size as recommended by manufacturer for

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service and capacity of system with connection not less than the line size in which installed. Filter driers with replaceable filters shall be furnished with one spare element of each type and size.

8. Flexible Metal Hose: Seamless bronze corrugated hose, covered with bronze wire braid, with standard copper tube ends. Provide in suction and discharge piping of each compressor.

9. Oil Separators: Provide for condensing units, as shown and as required by the manufacturer's installation directions. All welded steel construction with capacity to eliminate a minimum of 95 percent of the oil from the hot gas flowing through it. Provide manufacturer's published ratings for minimum and maximum refrigeration tonnage corresponding to this oil separating efficiency. Separator shall be equipped with a float valve to prevent return of the hot gas to crankcase, and shall have isolating stop valves so it can be opened and services without pumping out any other part of the system. ASME construction or UL listed.

1. Receivers: Conform to AHRI 495, steel construction, equipped with tappings for liquid inlet and outlet valves, pressure relief valve and liquid level indicator.

2. GAGES

A. Temperature Gages: Comply with ASME B40.200. Industrial duty type and in required temperature range for service in which installed. Gages shall have Fahrenheit scale in 2-degree graduations and with black number on a white face. The pointer shall be adjustable. Rigid stem type temperature gages shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gages shall be provided in thermal wells located 5 to 7 feet above the finished floor. Remote element type temperature gages shall be provided in thermal wells located 7 feet above the finished floor.

B. Vacuum and Pressure Gages: Comply with ASME B40.100 and provide with throttling type needle valve or a pulsation dampener and shut-off valve. Gage shall be a minimum of 3-1/2 inches in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gage range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

1. Suction: 30 inches Hg vacuum to 250 psig.

2. Discharge: 0 to 500 psig.

3. PIPE/CONDUIT ROOF PENETRATION COVER

A. See pipe penetration details on drawings.

B. Prefabricated Roof Curb: Galvanized steel or extruded aluminum 12 inches overall height, continuous welded corner seams, treated wood nailer, 1 1/2 inch thick, 3 lb/cu.ft. density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of

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the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

C. Penetration Cover: Galvanized sheet metal with flanged removable top. Provide 38 mm (1 1/2 inch) thick mineral fiber board insulation.

D. Flashing Sleeves: Provide sheet metal sleeves for conduit and pipe penetrations of the penetration cover. Seal watertight penetrations.

4. PIPE INSULATION FOR DX SYSTEMS

A. Refer to specification Section MECHANICAL INSULATION.

B. All exterior insulation shall be jacketed with aluminum pipe jacket unless specifically excluded by direction of the engineer.

C. All exterior insulation that is not jacketed shall be painted with 2 coats of exterior latex paint, or in a method compliant with the manufacturer's IOM.

D. All interior insulation that is exposed shall be painted per the interior finish schedule.

E. All interior insulation that is exposed to damage shall be protected by an aluminum jacket as required for exterior installation.

PART 3 EXECUTION

1. INSTALLATION

A. Install refrigerant piping and refrigerant containing parts in accordance with ASHRAE Standard 15 and ASME B31.5

1. Install piping as short as possible, with a minimum number of joints, elbow and fittings.

2. Install piping with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Space piping, including insulation, to provide 1 inch minimum clearance between adjacent piping or other surface. Use pipe sleeves through walls, floors, and ceilings, sized to permit installation of pipes with full thickness insulation.

3. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing.

4. Use copper tubing in protective conduit when installed below ground.

5. Install hangers and supports per ASME B31.5 and the refrigerant piping manufacturer's recommendations.

B. Joint Construction:

1. Brazed Joints: Comply with AWS "Brazing Handbook" and with filler materials complying with AWS A5.8/A5.8M.

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- a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper tubing.
- b. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
- c. Swab fittings and valves with manufacturer's recommended cleaning fluid to remove oil and other compounds prior to installation.
- d. Pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed. Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture.
- C. Protect refrigerant system during construction against entrance of foreign matter, dirt and moisture; have open ends of piping and connections to compressors, condensers, evaporators and other equipment tightly capped until assembly.
- D. Pipe relief valve discharge to outdoors for systems containing more than 100 lbs of refrigerant.
- E. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material.
- F. Seismic Bracing: Refer to specification Section SEISMIC RESTRAINTS REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS, for bracing of piping in seismic areas.

2. SIGNS AND IDENTIFICATION

- A. Systems containing more than 20 lb of refrigerant shall be provided with durable signs, in accordance with ANSI A13.1 and ANSI Z535.1, having letters not less than 1/2 inch in height designating:
 - 1. Valves and switches for controlling refrigerant flow, the ventilation and the refrigerant compressor(s).
 - 2. Signs on all exposed high pressure and low pressure piping installed outside the machinery room, with name of the refrigerant and the letters "HP" or "LP."
 - 3. The kind and total number of pounds of refrigerant required in the system for normal operations, and the field test pressure applied.
 - 4. The name and address of the installer.

3. FIELD QUALITY CONTROL

Prior to initial operation examine and inspect piping system for conformance to plans and specifications and ASME B31.5. Correct equipment, material, or work rejected because of defects or nonconformance with plans and specifications, and ANSI codes for pressure piping.

- A. After completion of piping installation and prior to initial operation, conduct test on piping system according to ASME B31.5. Furnish materials and equipment required for tests. If the test fails, correct defects and perform the test again until it is satisfactorily done and all joints are proved tight.
 - 1. Every refrigerant-containing parts of the system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gages, control mechanisms and

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systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.

2. The high and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure relief device protecting the high or low side of the system, respectively, except systems erected on the premises using non-toxic and non-flammable Group A1 refrigerants with copper tubing not exceeding NPS 5/8. This may be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 68 degrees F minimum.

B. Test Medium: A suitable dry gas such as nitrogen or shall be used for pressure testing. The means used to build up test pressure shall have either a pressure limiting device or pressure-reducing device with a pressure-relief device and a gage on the outlet side. The pressure relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system components.

4. SYSTEM TEST AND CHARGING

A. System Test and Charging: As recommended by the equipment manufacturer or as follows:

1. Connect a drum of refrigerant to charging connection and introduce enough refrigerant into system to raise the pressure to 10 psi gage. Close valves and disconnect refrigerant drum. Test system for leaks with halide test torch or other approved method suitable for the test gas used. Repair all leaking joints and retest.

2. Connect a drum of dry nitrogen to charging valve and bring test pressure to design pressure for low side and for high side. Test entire system again for leaks.

3. Evacuate the entire refrigerant system by the triplicate evacuation method with a vacuum pump equipped with an electronic gage reading in microns. Pull the system down to 500 microns and hold for four hours then break the vacuum with dry nitrogen (or refrigerant). Repeat the evacuation two more times breaking the third vacuum with the refrigeration to be charged and charge with the proper volume of refrigerant.

End of Section

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**SECTION 23 31 00
HVAC DUCTS**

PART 1 – GENERAL

1. DESCRIPTION

A. Ductwork and accessories for HVAC including the following:

1. Supply air, return air, outside air, exhaust, make-up air, and relief systems.

B. Definitions:

1. SMACNA Standards as used in this specification means the HVAC Duct Construction Standards, Metal and Flexible.

2. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.

3. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.

4. Exposed Duct: Exposed to view in a finished room, exposed to weather.

2. QUALITY ASSURANCE

- A. Fire Safety Code:** Comply with NFPA 90A.

- B. Duct System Construction and Installation:** Referenced SMACNA Standards are the minimum acceptable quality.

- C. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests:** Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes unless mechanical and energy code requirements stipulate a higher sealing classification.

- D. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.**

3. SUBMITTALS

- A. Submit in accordance with section requirements. Provided detailed shop drawings of duct system coordinated with building structure and other trades. No work on the duct systems shall commence until duct system shop drawings have been submitted to Project Engineer for review. Any work completed prior to duct system shop drawing review shall be at the risk of the contractor and shall be subject to modification or removal as required by the Project Architect or Engineer.**

- B. Manufacturer's Literature and Data:**

1. Rectangular ducts:

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- a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
- b. Duct liner.
- c. Sealants and gaskets.
- d. Access doors.
2. Round and flat oval duct construction details:
 - a. Manufacturer's details for duct fittings.
 - b. Duct liner.
 - c. Sealants and gaskets.
 - d. Access sections.
 - e. Installation instructions.
3. Volume dampers, back draft dampers.
4. Upper hanger attachments and duct support systems.
5. Fire dampers, fire doors, and smoke dampers with installation instructions.
6. Flexible connections.
7. Instrument test fittings.
8. Details and design analysis of alternate or optional duct systems.

PART 2 PRODUCTS

1. DUCT MATERIALS AND SEALANTS

A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, G90 galvanizing. Duct sheet metal thickness shall be in accordance with the SMACNA Duct Construction Manual.

B. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards for recommended seal class. If project codes enforce a higher degree of seal classification to meet mechanical and energy code requirements, then all HVAC ductwork shall be sealed to Class A. Wet, grease and special exhaust will have separate sealing requirements.

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1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer.
2. Gaskets in Flanged Joints: Soft neoprene. Approved factory made joints may be used.
2. DUCT CONSTRUCTION AND INSTALLATION
 - A. Duct installation methods, supports and other pertinent installation criteria shall be as indicated in the SMACNA Duct Construction Standards and SMACNA Duct Installation manuals.
 - B. Seal Class: All ductwork shall be sealed to Seal Class A.
 - C. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.
 1. Elbows: Diameters 3 through 8 inches shall be two sections die stamped, all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
 2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards.
 3. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards Access doors shall be hollow metal, insulated, with latches and door pulls. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain or to exterior of building.
 - D. Volume Dampers: Single blade or opposed blade, multilouver type as detailed in SMACNA Standards. Any dampers required to have a motorized damper shall be provided by the mechanical contractor as a complete system including the damper, actuator and linkage attachments. Actuators shall be as provided by Belimo. It shall be the responsibility of this contractor to provide all dampers and actuators as required and these systems shall be coordinated with the controls contractor and electrical contractor accordingly for power or control requirements.
 - E. Exposed Interior Ducting: Exposed Round Supply Trunks, Branch Ducts, and Fittings:
 1. Round, Double Wall Ducts (Supply): Galvanized steel meeting ASTM A653 standards with paint-grip finish, one inch (1") thick fiberglass insulation, spiral outer shell and perforated inner liner. A UL approved mylar film and taped joints shall separate the internal fiberglass lining and airstream. Duct systems shall be factory pre-fabricated. Ducts shall have spiral lockseam construction. Fittings shall be constructed of a perforated sheet metal internal liner, 1 inch layer of fiberglass insulation, mylar film and an outer galvanized pressure shell with paint-grip finish. Standing seam joints shall be used wherever possible on fittings. All standing seam joints shall be sealed with a UL Classified zero flame spread and zero smoke developed cement specially formulated for bonding metal-to-metal joints. All welded joints shall be coated with a protective paint, inside and out, to prevent damage to the galvanized surface. All double wall duct and fittings shall be provided with both an inner liner coupling and an outer pressure shell coupling. Outer shell connections can be by slip joint (up to 24" diameter) or bolted flanged joint with air seal gasket.

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F. Exterior Ducts or Ducts Exposed to Weather: Duct systems exposed to weather shall be a G-120 galvanized system with 2" rigid duct board insulation and an aluminum jacket. All insulation seams shall be taped with a fiberglass mesh material and shall receive two coats of mastic. Fiberglass mesh tape shall be applied into the first coat of mastic while mastic is still wet. Second coat shall be applied once first coat is completely cured. Aluminum jacketing shall be continuous with seams only occurring on the bottom portion of the duct system. The top of the aluminum jacket shall be tented to ensure the ponding of water is not possible on the top of the duct system. Aluminum jacket shall be sealed on the bottom of the duct system with duct mastic and shall be secured through the use of sheet metal screws or rivets of similar material.

G. DUCT ACCESS DOORS, PANELS AND SECTIONS

1. Provide access doors (as well as associated ceiling access panels – refer to Architectural specifications), sized and located for maintenance work, upstream, in the following locations:
 - a. Each duct mounted coil and humidifier.
 - b. Each fire damper (for link service), smoke damper and automatic control damper.
 - c. Each duct mounted smoke detector.
 - d. As otherwise required by prevailing codes or applicable standards (ASHRAE, NFPA, etc.).
2. Openings shall be as large as feasible in small ducts, 12 inch by 12 inch minimum where possible. Access sections in insulated ducts shall be doublewall, insulated.
3. For all duct types, refer to SMACNA HVAC Duct Construction Standards for additional requirements.

H. FIRE DAMPERS

1. Galvanized steel, interlocking blade type, UL listing and label, 1 1/2 hour rating, 160 degrees F fusible link, 100 percent free opening with no part of the blade stack or damper frame in the air stream. All fire dampers shall be dynamically rated.
2. Fire dampers in wet air exhaust shall be of stainless steel construction, all others may be galvanized steel.
3. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 14 gage, required to provide installation equivalent to the damper manufacturer's UL test installation. Submit manufacturer's installation instructions conforming to UL rating test. Damper size to match duct size.

I. TURNING VANES

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1. Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
2. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
3. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting
4. Vanes shall be single wall for ducts up to 48 inches wide. Ducts shall be double wall for larger dimensions. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows".

J. FLEXIBLE CONNECTORS

1. Indoor System, Flexible Connector Fabric: Provide glass fabric double coated with neoprene. Fabric shall be 26 oz/square yard minimum weight, 480 lbf/inch in the warp tensile strength, 360 lbf/inch in filling tensile strength and shall have a service temperature of minus 40 to plus 200 degrees F.
2. Outdoor system, Flexible Connector Fabric: Provide glass fabric double coated with weatherproof, synthetic rubber resistant to UV Rays and ozone. Fabric shall be 24 oz/square yard minimum weight, 530 lbf/inch in the warp tensile strength, 440 lbf/inch in filling tensile strength and shall have a service temperature of minus 50 to plus 220 degrees F.
3. Materials to be flame-retardant and noncombustic fabrics.
4. Coatings to comply with UL 181, Class 1.
5. Metal Edge connectors to be factory fabricated with 3-1/2-inch-wide fabric strip attached to 2 strips of 2-3/4-inch wide, 0.028 inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.
6. Thrust limits: Provide combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - a. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - b. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - f. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - g. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

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PART 3 – EXECUTION

A. INSTALLATION

1. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards.
2. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the project. Coordinate with other trades for space available and relative location of HVAC equipment and accessories in ceiling plenum and in ceiling grid. Duct sizes on the drawings are clear, inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
3. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards. Repair galvanized areas with galvanizing repair compound if duct is damaged during construction.
4. Provide bolted construction and tierod reinforcement in accordance with SMACNA Standards.
5. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.
6. Install duct hangers and supports in accordance with SMACNA Standards.
7. Install fire dampers, smoke dampers and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers, smoke dampers and combination fire/smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the prevailing codes or standards. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate resetting of fire dampers and operation of smoke dampers as required.
8. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
9. Flexible duct installation: Refer to SMACNA Standards. Ducts shall be continuous, single pieces not over 5 feet long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hour. Support ducts SMACNA Standards.

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10. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.

11. Control Damper Installation: Provide necessary blankoff plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.

12. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as required. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

B. DUCT LEAKAGE TESTS AND REPAIR

1. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.

2. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections. Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the Project Engineer on ductwork constructed up to the 2" WG duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 2" WG duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated.

3. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.

4. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.

5. All tests shall be performed in the presence of the Mechanical Contractor, the Commissioning Agent and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Project Engineer and identify leakage source with excessive leakage.

6. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Project Engineer and Commissioning Agent.

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7. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.
8. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.
9. Duct leakage testing shall be performed in accordance with LEED requirements on projects seeking LEED certification.

C. DUCTWORK EXPOSED TO WIND VELOCITY

1. Provide additional support and bracing to all exposed ductwork installed on the roof or outside the building to withstand the design wind velocity in accordance with the prevailing codes in effect at the time of permitting. This requirement shall include both attachment of the ducts to the supporting structure as well as the attachment of the duct support structure to the roof structure or other supporting mechanism.

End of Section

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SECTION 237413

CENTRAL-STATION AIR-HANDLING UNITS

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. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Refrigerant DX cooling coils
2. Hydronic heating coils.
3. Supply air fans.
4. Filtration.
5. Economizer outdoor- and return-air damper section.
6. Integral lighting and controls.

B. Manufacturer Qualifications:

1. Company specializing in manufacturing the products specified in this section with minimum of five years documented experience.
2. The management system governing the manufacture of this product is ISO (International Organization for Standardization) 9001:2008 certified.
3. Air-handling unit assembly shall have UL (Underwriters Laboratories) 1995 certification for safety, including use with electric heat.
4. Products requiring electric connection shall be listed and classified by ETL and CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.
5. Coil performance shall be certified in accordance with AHRI (Air-Conditioning, Heating, and Refrigerating Institute) Standard 410, latest edition.
6. Unit performance shall be rated in accordance with AHRI Standard 430 for Central Air Handling Units and subject to verification of rating accuracy by AHRI-sponsored, third party testing. Units shall meet NFPA (National Fire Protection Association) 90A requirements.

C. DELIVERY, STORAGE AND PROTECTION

1. All indoor units, painted or unpainted, shall be completely shrink-wrapped from the factory for protection during shipment. Tarping of bare units is unacceptable.
2. Inspect for transportation damage and store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

D. START-UP REQUIREMENTS

1. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, condensate properly trapped, piping connections verified and leak tested, belts aligned and tensioned, all shipping braces have been removed, and fan has been test run under observation.

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1.3 SUBMITTALS

- A. **Product Data:** Include manufacturer's technical data for each AHU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. **Submittals shall include the following:**
 - 1. Dimensioned plan and elevation view drawings, including motor starter and control cabinets, required clearances, and location of all field connections.
 - 2. Summary of all auxiliary utility requirements such as: electricity, water, compressed air, etc. Summary shall indicate quality and quantity of each required utility.
 - 3. Ladder type schematic drawing of the power and ancillary utility field hookup requirements, indicating all items that are furnished.
 - 4. Manufacturer's performance of each unit. Selection shall indicate, as a minimum, the following:
 - a. Input data used for selection.
 - b. Model number of the unit.
 - c. Net capacity.
 - d. Rated load amp draw.
 - e. Noise levels produced by equipment.
 - f. Fan curves.
 - g. Approximate unit shipping weight.

1.4 INFORMATIONAL SUBMITTALS

- A. **Coordination Drawings:** Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which AHUs will be attached.
- B. **Field quality-control test reports.**
- C. **Warranty:** Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

- A. **Operation and Maintenance Data:** For AHUs to include in operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. **Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.**
 - 1. **Filters:** One set of filters for each unit.

1.7 QUALITY ASSURANCE

- A. **ARI Compliance:**
 - 1. **ARI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil**
- B. **ASHRAE Compliance:**

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1. Comply with ASHRAE 15 for refrigeration system safety.
 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 WARRANTY

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

PART 2 - PRODUCTS

2.1. GENERAL DESCRIPTION

- A. Units shall ship in the number of sections necessary to meet project requirements and shall ship in as many splits as specified in selection software. Split options as follows:
1. Shipped in sections — shipping split.
 2. Shipped assembled — base rail break (ship attached).
 3. Shipped assembled — solid base rail.
- B. Unit shall be factory-supplied, central station air handler. The air-handling unit may consist of a fan with the following factory-installed components as indicated on the equipment schedule.
1. Integral Face and Bypass Section:
 - a. With hot water coil.
 - b. With steam coil.
 2. Filter Section:
 - a. 4-in. angle filters.
 3. Coil Section:
 - b. Direct expansion coil.
 - c. Hot water coil.
 4. Fan Section:
 - a. Horizontal draw-thru (supply, return, and exhaust).

2.2 UNIT CONSTRUCTION DESCRIPTION

- A. Casing Construction:
1. Unit shall be constructed of a complete frame with easily removable panels. Removal of any panel shall not affect the structural integrity of the unit.

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2. All units shall be supplied with 14-gage or heavier, G-90 galvanized steel base rails. Bolt-on legs are NOT acceptable. Perimeter lifting lugs for overhead lifting shall be provided on each shipping section. Slinging units in place of lifting lugs shall not be acceptable.
3. Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside.
4. Casing panels (top, sides, and bottom) shall be constructed of galvanized steel (18 gauge optional), and shall have one of the following exterior finishes as specified:
 - a. Pre-painted with a baked enamel finish passing 500-hour salt spray test (ASTM [American Society of Mechanical Engineers] B-117) for pre-painted steel and 125-hour marine level 1 cohesion test (ASTM G-85.A5) for pre-painted steel.
 - b. Unpainted G-90 galvanized steel.
5. Casing panels (top, sides, and bottom) shall be constructed of galvanized steel (18 gauge optional) or stainless steel, and shall have one of the following interior finishes as specified:
 - a. G-90 pre-coated galvanized steel with a silver zeolite antimicrobial material registered by the US EPA (Environmental Protection Agency) for use in HVAC applications.
 - b. Unpainted G-90 galvanized steel.
 - c. Unpainted 304 stainless steel.
 - d. Option for aluminum diamond treadplate floors
6. Casing panels (top, sides, and bottom) shall be one piece, double-wall construction with foam insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.
7. Casing deflection shall not exceed a L/240 ratio when subject to an internal pressure of ± 8 -in. wg and shall exhibit no permanent deformation at ± 9 -in. wg. L is defined as the longest linear panel or cabinet length (measured to AHRI 1350 Cd level 2).
8. Casing leakage rate shall be less than 1% at 8 in. wg of nominal unit airflow or 50 cfm, whichever is greater. Leakage rate shall be tested and documented on a routine basis on random production units. Optionally, factory witness leak testing and/or test reports shall be available.
9. Side panels shall be easily removable for access to unit and shall seal against a full perimeter automotive style gasket to ensure a tight seal.
10. The panel retention system shall comply with UL 1995 which states all moving parts (for example, fan blades, blower wheels, pulleys, and belts) that, if accidentally contacted, could cause bodily injury, shall be guarded against accidental contact by an enclosure requiring tools for removal.
11. Accessibility options shall be as follows:
 - a. Hinged, lockable double-wall access door on either side with removable access panel(s) on the other side.
 - b. Hinged, lockable double-wall access doors on both sides.
 - c. Removable double-wall access panels on both sides.
12. Depending on the options selected and the remaining available space inside each section, the following options may be available:
 - a. Reinforced glass viewports shall be factory-installed on the access panel(s) or door(s) of the section.
 - b. Marine lights shall be factory installed with or without GFCI (ground fault circuit interrupter) convenience outlets.
13. Fan supports, structural members, panels, or flooring shall not be welded, unless aluminum, stainless steel, or other corrosion-resistant material is used. Painted welds on unit exterior steel or galvanized steel are not acceptable.

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14. All coil sections shall be doublewall construction with foam insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13. Single height coil sections shall have removable frame sections to facilitate vertical coil extraction.

B. Access Doors:

Access doors shall be one piece, hinged, lockable double-wall construction with foam insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.

C. Drain Pans:

Drain pans shall be foam insulated double-wall galvanized or stainless steel construction (18 gauge optional). The pan shall be sloped toward the drain connection. Drain pan shall have 1 1/2-in. MPT connection exiting through the hand side or opposite side of the casing as specified. One drain outlet shall be supplied for each cooling coil section. Drain pan shall allow no standing water and comply with ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers). Standard 62.1-2010. Where 2 or more coils are stacked in a coil bank, intermediate drain pans shall be provided and the condensate shall be piped to the bottom drain pan. The bottom coil shall not serve as a drain path for the upper coil.

C. Drain Pans:

2.3. FANS

A. General:

1. Forward-curved fan sections shall have one double-width double-inlet (DWDI) fan wheel and scroll. They shall be constructed of galvanized steel with baked enamel. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have an AMCA class rating corresponding to the static pressure at which the fan is designed to operate (Class I or II). Completed fan assembly shall be dynamically balanced in accordance with AHRI Guideline G and ANSI S2.19 at design operating speed using contract drive and motor if ordered.

5. Fan assembly vibration shall not exceed 0.248 in. per second when mounted on active isolators. Vibration shall be measured in both vertical and horizontal directions at the specified fan operating speed using specified motor. For testing purposes, accelerometers shall be mounted on the motor near the bearing locations and removed before shipment.

6. All fan sled components shall provide corrosion protection to pass 100-hour salt spray test per ASTM B-117.

7. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with a maximum operating speed 25% below the first critical.

8. Belt drive fan motor shall be mounted within the fan section casing on slide rails equipped with adjusting screws. Motor shall be premium efficiency, open drip-proof or totally enclosed fan cooled NEMA (National Electrical Manufacturers Association) Design A or B with size and electrical characteristics as shown on the equipment schedule. Motor shall be mounted on a horizontal flat surface and shall not be supported by the fan or its structural members. All three-phase motors shall have a $\pm 10\%$ voltage utilization range and a 1.15 minimum service factor. Motor shall be compliant with the Energy Independence and Security Act (EISA) of 2007 where applicable. Single-phase motors shall be available up to and including 5 hp.

B. Performance Ratings:

Fan performance shall be rated and certified in accordance with AHRI Standard 430, latest edition.

C. Sound Ratings:

Manufacturer shall submit first through eighth octave sound power for fan discharge and casing radiated sound. Sound ratings shall be tested in accordance with AHRI 260.

D. Mounting:

Fan scroll, wheel, shaft, bearings, drives, and motor shall be mounted on a common base assembly. The base assembly is isolated from the outer casing with factory-installed isolators and rubber vibration

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absorbent fan discharge seal. A canvas style duct connection between fan discharge and cabinet is not acceptable. Units shall use 2-in. deflection spring isolators.

E. Fan Accessories:

1. Forward-curved fans:
 - a. Variable frequency drives with or without bypass.
 - b. Magnetic motor starters.
 - c. Motor disconnects.
 - d. Airflow measuring piezo ring.
 - e. Piezo ring transducer.
 - f. Motor shaft grounding ring.
 - g. Belt guards.
 - h. Inlet screen.

F. Flexible Connection:

The base assembly is isolated from the outer casing with factory-installed isolators and rubber vibration absorbent fan discharge seal. A canvas style duct connection between fan discharge and cabinet is not acceptable.

2.4. BEARINGS AND DRIVES

A. Bearings:

Self-aligning, grease lubricated, anti-friction with lubrication fittings extended to drive side of fan section. Optional grease fittings extended to the exterior of the casing are available. All bearing life calculations shall be done in accordance with ABMA 9 for ball bearings and ABMA 11 for roller bearings.

1. Size 03 to 110 forward-curved fans: Cartridge type bearings for Class I fans. Heavy-duty pillow block type, self-aligning, regreasable ball or roller type bearings selected for a minimum average life (L50) of 200,000 hours or optionally for an (L50) of 500,000 hours.
2. Size 03 to 110 airfoil fans: Heavy-duty pillow block type, self-aligning, regreasable ball or roller type bearings selected for a minimum average life (L50) of 200,000 hours or optionally for an (L50) of 500,000 hours.
3. Size 06 to 110 belt-drive plenum fans: Heavy-duty pillow block type, self-aligning, regreasable roller type bearings selected for a minimum average life (L50) of 200,000 hours or optionally for an (L50) of 500,000 hours.

B. Shafts:

Fan shafts shall be solid steel, turned, ground, polished and coated with a rust inhibitor.

C. V-Belt Drive:

Drive shall be designed for a minimum 1.2 service factor as standard with a 1.5 service factor option and/or a factory-supplied extra set of belts. Drives shall be fixed pitch with optional variable pitch for motors 15 hp and less. All drives shall be factory mounted, with sheaves aligned and belts properly tensioned.

2.5 COILS

A. All water, steam and direct expansion (DX) refrigerant coils shall be provided to meet the scheduled performance. All coil performance shall be certified in accordance with AHRI Standard 410. All water and direct expansion coils shall be tested at 450 psig air pressure. Direct expansion coils shall be designed and tested in accordance with ANSI/ASHRAE 15 Safety Code for Mechanical Refrigeration (latest edition). Factory-supplied 1/2-in. OD coils shall be covered under the standard product one-year limited warranty. All steam coils, integral face and bypass coils and 5/8-in. OD coils shall be warranted for a period not in

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excess of 12 months from their shipment from the manufacturer. Coil epoxy coating shall be covered under a 5-year limited warranty from the date of shipment from the manufacturer.

B. General Fabrication:

1. All water and refrigerant coils shall have minimum 1/2-in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.016 inches. Optional tube wall thickness of 0.025 in. shall be supplied, if specified.
2. Optionally, water coils shall have minimum 5/8-in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.020 inches. Optional tube wall thickness of 0.035 in. shall be supplied, if specified.
3. Aluminum plate fin type with belled collars. Optional copper plate fins shall be supplied, if specified. Fin type shall be sine wave construction.
4. Aluminum-finned coils shall be supplied with die-formed casing and tube sheets of mill galvanized steel or stainless steel as specified. Copper-finned coils shall be supplied with stainless steel casing and tube sheets.

C. Hydronic Heating and Cooling Coils:

1. Headers shall be constructed of steel with steel MPT connections. Headers shall have drain and vent connections accessible from the exterior of the unit. Optional non-ferrous headers and red brass MPT connections shall be supplied if specified.
2. Configuration: Coils shall be drainable, with non-trapping circuits. Coils will be suitable for a design working pressure of 300 psig at 200 F.

F. Refrigerant Coils:

1. Headers shall be constructed of copper with brazed joints.
2. Brass refrigerant distributors and seamless copper distribution tubes shall be factory supplied to ensure uniform flow.
3. Thermal expansion valves (TXV) and nozzles shall be factory installed and piped to the exterior of the casing. Equalizer lines shall be piped internal to the coil header.
4. Suction and liquid line pairs shall be located next to each other for easy circuit identification. A custom label showing TXV size, nozzle size and condensing unit circuit pairing shall be located on the side of the coil section.
5. Standard circuiting selections include:
 - a. Single distributor arrangement for sizes 03-17.
 - b. Row split intertwined multiple distributor arrangement for sizes 03-110.
 - c. Face split multiple distributor arrangement for sizes 03-110.
6. Submittals must include a DX coil and condensing unit cross plot to show that the coil and condensing unit capacity match at the rated design conditions.

2.6 FILTER SECTIONS

B. Angle filter sections shall accept either 2-in. or 4-in. filters of standard sizes, arranged in a horizontal V formation.

G. Differential Pressure Gages:

1. Housing shall be constructed of a glass filled nylon case and acrylic lens. Exterior finish shall be coated black.
2. Accuracy shall be $\pm 5\%$ of full scale throughout range at 70 F.
3. Pressure limits shall be 30 psig continuous to either pressure connection.
4. Temperature limits shall be 20 to 120 F.

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5. Diameter of dial face shall be 2.33 in.
6. Process connections shall be barbed, 3/16-in. for ID tubing.

2.7 ELECTRICAL ACCESSORIES

A. Marine Lights and Convenience Outlets:

1. Cast, non-ferrous metal, weatherproof, fixture.
2. Cast, non-ferrous metal, weatherproof, electrical junction box.
3. Gasketed, heat and shock resistant glass globe protects against moisture and debris.
4. Cast, non-ferrous metal lamp guard to protect glass globe.
5. UL and CSA listed.
6. 100 watt type 'A' lamp maximum capacity.
7. Each fixture is equipped with a 9.5 watt, 120 volt 800 lumen LED lamp with an average rated life of 25,000 hours, factory installed.
8. Metallic, single gang, electrical junction box, UL listed.
9. With convenience outlet: Factory supplied and wired, SPST, toggle switch and 15 amp, 120 vac/60 Hz, NEMA 5-15 type, ground fault circuit interrupt (GFCI) receptacle, UL listed.
10. Without convenience outlet: Factory supplied and wired, SPST, UL listed toggle switch.
11. Each fixture is factory wired to an externally mounted switch box. (Field power connections are made to the switch box mounted externally on the unit.)
12. All factory wiring penetrating through the panel is protected in 'RIGID' type metal conduit.

B. Disconnects:

Factory-supplied disconnects shall be covered under a 1 year limited warranty from the manufacturer from the date of shipment.

1. 115-230 volt/single-phase non-fused disconnects shall have the following characteristics:
 - a. Plated current carrying components for superior corrosion protection.
 - b. Factory-installed equipment grounding terminals with slot/square drive screws.
 - c. Rated for motor disconnect applications (10 Hp maximum).
 - d. NEMA type 3R non-metallic enclosure.
 - e. Up to 10,000 rms symmetrical amperes SCCR, when protected by a fuse or circuit breaker rated 60 amperes or less.
 - f. Cover padlock hasp.
 - g. Pull-out cartridge type.
 - h. UL listed.
4. 380-575 volt/3-phase fused and non-fused disconnects shall have the following characteristics:
 - a. Visible switch blades with for positive "OFF" indication.
 - b. Quick-make, quick-break operating mechanism.
 - c. Dual cover interlock.
 - d. Color coded "ON" — "OFF" indicator handle.
 - e. Cover padlock hasp and handle lock "OFF" provision for multiple padlocks.
 - f. 600 vac maximum.
 - g. Factory supplied and installed class RK5 fuses (fused disconnects only).
 - h. Up to 200,000 rms symmetrical amperes SCCR, utilizing appropriately rated, factory-supplied Class R fuses.

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- i. Horsepower rated for motor applications.
- j. Spring reinforced plated copper fuse clips.
- k. Tangential combination knockouts.
- l. NEMA type 1 enclosures.
- m. Insulated, bondable solid neutral assemblies.
- n. Wire terminations suitable for aluminum or copper conductors.
- o. UL listed.
- p. Meet or exceed NEMA KS1-1999.

C. Starters:

Factory-supplied disconnects shall be covered under a 1 year limited warranty from the manufacturer from the date of shipment.

- 1. Starter without disconnect:
 - a. Adjustable motor overload with trip indication.
 - b. Manual overload reset button (accessible without opening enclosure).
 - c. 115-v fused secondary control transformer (fuse included — fused primary and secondary over 50 amps).
 - d. Hand/Off/Auto selector switch (accessible without opening enclosure).
 - e. Separate 4-position terminal strip for remote H-O-A wiring.
 - f. C series contactors.
 - g. Horsepower rated for motor applications.
 - h. NEMA 4X type non-metallic enclosures.
 - i. Lug connections for field wiring.
 - j. Factory mounted, wired, and run tested with factory-supplied motor.
 - k. UL listed.
- 2. Combination Starter/Disconnect:
 - a. Non-fused UL 508 disconnect switch with lockable handle (locks not provided).
 - b. Cover interlock.
 - c. Adjustable motor overload with trip indication.
 - d. Manual overload reset button (accessible without opening enclosure).
 - e. 115-v fused secondary control transformer (fuse included — fused primary and secondary over 50 amps).
 - f. Hand/Off/Auto selector switch (accessible without opening enclosure).
 - g. Separate 4-position terminal strip for remote H-O-A wiring.
 - h. C series contactors.
 - i. Horsepower rated for motor applications.
 - j. NEMA 4X type non-metallic enclosures.
 - k. Lug connections for field power wiring.
 - l. Factory mounted, wired, and run tested with factory-supplied motor.
 - m. UL listed.

D. External Bypass for Variable Frequency Drives:

Factory-supplied bypasses shall be covered under a 1 year limited warranty from the manufacturer from the date of shipment.

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1. 200-230 v/3 Ph/60 Hz (1 to 7.5 Hp), 460-575 v/3 Ph/60 Hz (1 to 20 Hp), 380 v/3 Ph/50 Hz (1 to 15 Hp):
 - a. 4-position panel-mounted disconnect style switch with lockable handle (locks not provided), meets OSHA 1910.
 - b. Switch position indication (LINE/OFF/ DRIVE/TEST).
 - c. Adjustable motor overload with trip indication (LINE position).
 - d. Manual overload reset button.
 - e. Horsepower rated for motor applications.
 - f. Direct control (no contactors, relays, or holding coils).
 - g. Complete isolation of inverter in LINE position.
 - h. NEMA 12 type metal enclosures.
 - i. Terminal strip provided for field power supply wiring.
 - j. Lug connection for field ground wire.
 - k. Gold flashed, auxiliary switch contact set (for switch position monitoring).
 - l. Factory mounted, wired to VFD and motor, and run tested (motor and VFD must be factory supplied and installed).
 - m. UL; UL, Canada; CE listed.
2. 200-230 v/3 Ph/60 Hz (10 to 75 Hp), 460-575 v/3 Ph/60 Hz (25 to 150 Hp), 380 v/3 Ph/50 Hz (20 to 75 Hp):
 - a. 4-position panel-mounted disconnect style switch with lockable handle (locks not provided), meets OSHA 1910.
 - b. Switch position indication (LINE/OFF/ DRIVE/TEST).
 - c. Adjustable motor overload with trip indication (in LINE position).
 - d. Manual overload reset button.
 - e. Horsepower rated for motor applications.
 - f. 115-v control transformer with fused secondary (fused primary on units over 50 amps).
 - g. Contactor for Line Start/Stop.
 - h. Door-mounted Line Start and Line Stop pushbuttons.
 - i. Complete isolation of inverter in LINE position.
 - j. NEMA 12 type metal enclosures.
 - k. Terminal strip provided for field power supply wiring.
 - l. Lug connection for field ground wire.
 - m. Gold flashed, auxiliary switch contact set (for switch position monitoring).
 - n. Factory mounted, wired to VFD and motor, and run tested (motor and VFD must be factory supplied and installed).
 - o. UL; UL, Canada; CE listed.
- E. Variable Frequency Drives:
 1. Referenced Standards and Guidelines:
 - a. Institute of Electrical and Electronic Engineers (IEEE)
 - 1) IEEE 519-1992, Guide for Harmonic Content and Control.
 - b. Underwriters Laboratories (as appropriate)
 - 1) UL508
 - 2) UL508A
 - 3) UL508C

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- c. National Electrical Manufacturer's Association (NEMA)
 - 1) ICS 7.0, AC Adjustable Speed Drives
- d. International Electrotechnical Commission (IEC)
 - 1) EN/IEC 61800-3
- e. National Electric Code (NEC)
 - 1) NEC 430.120, Adjustable-Speed Drive Systems
- f. International Building Code (IBC)
 - 1) IBC 2012 Seismic – referencing ASC 7-05 and ICC AC-156
 - 2. Qualifications:
 - a. VFDs and options shall be UL508 listed as a complete assembly. The base VFD shall be UL listed for 100 kA SCCR without the need for external input fuses.
 - b. CE Mark – The base VFD shall conform to the European Union Electromagnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level (Category C2). Base drives that only meet the Second Environment (Category C3, C4) shall be supplied with filters to bring the drive in compliance with the First Environment levels.
 - c. The entire VFD assembly, including the bypass (if specified), shall be seismically certified and labeled as such in accordance with the 2012 International Building Code (IBC):
 - 1) VFD manufacturer shall provide Seismic Certification and Installation requirements at time of submittal.
 - 2) Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake test data as defined by ICC AC-156.
 - 3) Seismic ratings based upon calculations alone are not acceptable. Certification of Seismic rating must be based on testing done in all three axis of motion.
 - 4) Special seismic certification of equipment and components shall be provided by OSHPD preapproval.
- 3. Factory-mounted variable frequency drives (VFDs) shall be wired to factory-supplied motors.
- 4. Factory-supplied VFDs are programmed and started up from the factory and qualify the VFD, through ABB, for a 24-month warranty from date of commissioning or 30 months from date of sale, whichever occurs first.
- 5. The VFD parameters are programmed into the controller and removable keypad. In the event that the VFD fails and needs replacement, the program can then be uploaded to the replacement VFD via the original keypad.
- 6. The VFD package as specified herein and defined on the VFD schedule shall be enclosed in a UL Type enclosure (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in a facility where the management system governing the manufacture of this product is ISO 9001:2008 certified.
- 7. The VFD shall provide full rated output from a line of $\pm 10\%$ of nominal voltage. The VFD shall continue to operate without faulting from a line of $+30\%$ to -35% of nominal voltage.
- 8. VFDs shall be capable of continuous full load operation under the following environmental operating conditions:
 - a. -15 to 40 C (5 to 104 F) ambient temperature. Operation to 50 C shall be allowed with a 10% reduction from VFD full load current.
 - b. Altitude 0 to 3300 feet above sea level. Operation to 6600 shall be allowed with a 10% reduction from VFD full load current.
 - c. Humidity less than 95%, non-condensing.
- 9. All VFDs shall have the following standard features:
 - a. All circuit boards shall be coated to protect against corrosion.

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- b. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
- c. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
- d. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery backup with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. VFD programming shall be held in non-volatile memory and is not dependent on battery power.
- e. The VFDs shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
- f. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).
- g. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
- h. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds every minute. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
- i. VFDs through 200 HP shall have internal swinging (non-linear) chokes providing impedance equivalent to 5% to reduce the harmonics to the power line. Swinging choke shall be required resulting in superior partial load harmonic reduction. Linear chokes are not acceptable. 5% impedance may be from dual (positive and negative DC bus) chokes, or 5% swinging AC line chokes. VFDs with only one DC choke shall add an AC line choke.
- j. The input current rating of the VFD shall not be greater than the output current rating. VFDs with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.122. Input and output current ratings must be shown on the VFD nameplate.
- k. The VFD shall include a coordinated AC transient surge protection system consisting of 4 MOVs (phase to phase and phase to ground), a capacitor clamp, 1600 PIV Diode Bridge and internal chokes. The MOV's shall have a minimum 125 joule rating per phase across the diode bridge. VFDs that do not include coordinated AC transient surge protection shall include an external TVSS (Transient Voltage Surge Suppressor).
- l. The VFD shall provide a programmable loss-of-load (broken belt/broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and/or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.
- m. The VFD shall include multiple "two zone" PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4 to 20mA, 0 to 10V, and/or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for "two zone" control.
- n. If the input reference is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and/or over the serial communication bus.

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- o. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.
- 10. All VFDs to have the following adjustments:
 - a. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.
 - b. Two (2) PID Set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are typically used for night setback, switching between summer and winter set points, etc.
 - c. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (i.e. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
 - d. Two (2) programmable analog inputs shall accept current or voltage signals.
 - e. Two (2) programmable analog outputs (0 to 20 mA or 4 to 20 mA). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.
 - f. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.
 - g. Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable. Drives that have only two (2) relay outputs must provide an option card that provides additional relay outputs.
 - h. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing." The safety input status shall also be transmitted over the serial communications bus.
 - i. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 to 120 seconds. Start delay shall be active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications), and when switching from drive to bypass.
 - j. Seven (7) programmable preset speeds.
 - k. Two independently adjustable accel and decel ramps with 1 to 1800 seconds adjustable time ramps.
 - l. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.

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- m. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
- n. The VFD shall include password protection against parameter changes.
- 11. The keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:
 - a. Start-up assistant
 - b. Parameter assistants
 - 1) PID assistant
 - 2) Reference assistant
 - 3) I/O assistant
 - 4) Serial communications assistant
 - 5) Option module assistant
 - 6) Panel display assistant
 - 7) Low noise set-up assistant
 - c. Maintenance assistant
 - d. Troubleshooting assistant
 - e. Drive optimizer assistants
- 12. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
 - a. Output Frequency
 - b. Motor Speed (RPM,%, or Engineering units)
 - c. Motor Current
 - d. Motor Torque
 - e. Motor Power (kW)
 - f. DC Bus Voltage
 - g. Output Voltage
- 13. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward). 2) Operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command.
- 14. Serial Communications
 - a. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus*, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet†. [Optional protocols for LonWorks**, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.] Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet). Use of non-certified protocols is not allowed.
 - b. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

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- 1) Data Sharing – Read Property – B.
 - 2) Data Sharing – Write Property – B.
 - 3) Device Management – Dynamic Device Binding (Who-Is; I-Am).
 - 4) Device Management – Dynamic Object Binding (Who-Has; I-Have).
 - 5) Device Management – Communication Control – B.
- c. Serial communication capabilities shall include, but not be limited to; run-stop controls, speed set adjustment, and lock and unlock the keypad. The drive shall have the capability of allowing the BAS to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The BAS shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.
- d. Serial communication in bypass (if bypass is specified) shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the BAS to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The BAS shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.
- e. The VFD / bypass shall allow the BAS to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function. The analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive and bypass' digital (Form-C relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive and bypass' digital inputs shall be capable of being monitored by the BAS system. This allows for remote monitoring of which (of up to 4) safeties are open.
- f. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value / hot water valve control, etc. Both the VFD PID control loop and the independent PID control loop shall continue functioning even if the serial communications connection is lost. As default, the VFD shall keep the last good set point command and last good DO and AO commands in memory in the event the serial communications connection is lost and continue controlling the process.
15. EMI/RFI filters. All VFDs shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level (Category C2) with up to 100 feet of motor cable. Second environment (Category C3, C4) is not acceptable, no Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment (C2).
16. Drive options shall be furnished and mounted by the drive manufacturer as defined on the VFD schedule. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
17. Eclipse Bypass (Optional) – Bypasses shall be furnished and mounted by the drive manufacturer as defined on the VFD schedule. All VFD with bypass configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
- a. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses. UL Listed motor overload protection shall be provided in both drive and bypass modes.
 - b. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the "Off" position before either enclosure may be accessed.
 - c. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 Amps and this rating shall be indicated on the UL data label.

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- d. The drive and bypass package shall be seismic certified and labeled to the IBC:
 - 1) Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake table test data as defined by ICC AC-156.
 - 2) Special seismic certification of equipment and components shall be provided by OSHPD preapproval.
- e. Drive Isolation Fuses - To ensure maximum availability of bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs which have no such fuses, or that incorporate fuses common to both the VFD and the bypass, will not be accepted. Third contactor "isolation contactors" are not an acceptable alternative to fuses, as contactors could weld closed and are not an NEC recognized disconnecting device.
- f. The bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out/low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
- g. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.
- h. The bypass system shall be designed for stand-alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair/ replacement. Serial communications shall remain functional even with the VFD removed. Bypass systems that do not maintain full functionality with the drive removed are not acceptable.
- i. Serial communications – the bypass shall be capable of being monitored and/or controlled via serial communications. On-board communications protocols shall include ModBus RTU; Johnson Controls N2; Siemens Building Technologies FLN (P1); and BACnet MS/TP.
 - 1) Serial communication capabilities shall include, but not be limited to: bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the BAS to monitor feedback such as, current (Amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The BAS shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus and/or via a Form-C relay output – keypad "Hand" or "Auto" selected, bypass selected, and broken belt indication. The BAS system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 50 field serial communications points shall be capable of being monitored in the bypass mode.
 - 2) The bypass serial communications shall allow control of the drive/bypass (system) digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The system digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. All system analog and digital I/O shall be capable of being monitored by the BAS system.
- j. There shall be an adjustable motor current sensing circuit for the bypass and VFD modes to provide proof of flow (broken belt) indication. The condition shall be indicated on the keypad display, transmitted over the BAS and/or via a Form-C relay output contact closure. The broken belt indication shall be programmable to be a system (drive and bypass) indication. The broken belt condition sensing algorithm shall be programmable to cause a warning or system shutdown.
- k. The digital inputs for the system shall accept 24VDC. The bypass shall incorporate an internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 mA of 24 VDC for use by others to power external devices.

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l. There shall be a coordinated run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, time-clock control, digital input, or serial communications) the bypass shall provide a dry contact closure that will signal the damper to open before the motor can run. When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a bypass system input and allows motor operation. Up to four separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. This feature will also operate in Fireman's override/smoke control mode.

m. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor condition shall be indicated on the bypass LCD display, programmed to activate a Form-C relay output, and/or over the serial communications protocol.

n. The bypass control shall include a programmable time delay bypass start including keypad indication of the time delay. A Form C relay output commands the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 to 120 seconds.

o. There shall be a keypad adjustment to select manual or automatic transfer to bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to bypass mode and which faults require a manual transfer to bypass. The user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:

- 1) Over current
- 2) Over voltage
- 3) Under voltage
- 4) Loss of analog input

p. The following operators shall be provided:

- 1) Bypass Hand-Off-Auto
- 2) Drive mode selector
- 3) Bypass mode selector
- 4) Bypass fault reset

q. The bypass shall include the ability to select the operating mode of the system (VFD/Bypass) from either the bypass keypad or digital input.

r. The bypass shall include a two line, 20 character LCD display. The display shall allow the user to access and view:

- 1) Energy savings – in US dollars
- 2) Bypass motor amps
- 3) Bypass input voltage-average and individual phase voltage
- 4) Bypass power (kW)
- 5) Bypass faults and fault logs
- 6) Bypass warnings
- 7) Bypass operating time (resettable)
- 8) Bypass energy (kilowatt hours – resettable)
- 9) I/O status
- 10) Parameter settings/programming
- 11) Printed circuit board temperature

s. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.

- 1) Power-on (Ready)
- 2) Run enable
- 3) Drive mode selected
- 4) Bypass mode selected

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- 5) Drive running
 - 6) Bypass running
 - 7) Drive fault
 - 8) Bypass fault
 - 9) Bypass H-O-A mode
 - 10) Automatic transfer to bypass selected
 - 11) Safety open
 - 12) Damper opening
 - 13) Damper end-switch made
- t. The Bypass controller shall have six programmable digital inputs, and five programmable Form-C relay outputs. This I/O allows for a total System (VFD and Bypass) I/O count of 24 points as standard. The bypass I/O shall be available to the BAS system even with the VFD removed.
- u. The on-board Form-C relay outputs in the bypass shall be programmable for any of the following indications.
- 1) System started
 - 2) System running
 - 3) Bypass override enabled
 - 4) Drive fault
 - 5) Bypass fault
 - 6) Bypass H-O-A position
 - 7) Motor proof-of-flow (broken belt)
 - 8) Overload
 - 9) Bypass selected
 - 10) Bypass run
 - 11) System started (damper opening)
 - 12) Bypass alarm
 - 13) Over temperature
- v. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.
- w. The bypass shall include a supervisory control mode. In this bypass mode, the bypass shall monitor the value of the VFDs analog input (feedback). This feedback value is used to control the bypass contactor on and off state. The supervisory mode shall allow the user to maintain hysteresis control over applications such as cooling towers and booster pumps.
- x. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include "FireStat," "FreezStat," "Over pressure" and "Low suction." The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.
- y. Smoke Control Override Mode (Override 1) – The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire/Smoke Control System. The Smoke Control Override Mode action is not programmable and will always function as described in the bypass User's Manual documentation. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties. All keypad control, serial communications control, and normal customer start/stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.
- z. Fireman's Override Mode (Override 2) – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge some digital inputs, all digital inputs, ignore digital inputs or any combination of the above. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires.

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The Override 2 action may be programmed for "Run-to-Destruction." The user may also force the unit into Override 2 via the serial communications link.

18. VFD with Integral Disconnect:
 - a. UL listed by the drive manufacturer as a complete assembly.
 - b. UL 508 labeled.
 - c. Capable of being locked by three padlocks.

PART 3 - CENTRAL-STATION AIR HANDLING UNITS EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of AHU's.
- B. Examine roughing-in for AHUs to verify actual locations of piping and duct connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Install piping adjacent to AHUs to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.
- C. Tests and Inspections:
 1. After installing AHUs and after electrical circuitry has been energized, test units for compliance with requirements.
 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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- D. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to coils, and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Remove packing from vibration isolators.
9. Inspect operation of dampers.
10. Verify lubrication on fan and motor bearings.
11. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
12. Start unit according to manufacturer's written instructions.
 - a. Complete startup sheets and attach copy with Contractor's startup report.
13. Inspect and record performance of interlocks and protective devices; verify sequences.
14. Operate unit for an initial period as recommended or required by manufacturer.
15. Calibrate thermostats.
16. Adjust and inspect high-temperature limits.
17. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
18. Inspect controls for correct sequencing of heating, cooling, mixing dampers, and normal and emergency shutdown.
19. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Outdoor-air intake volume.
20. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.5 CLEANING AND ADJUSTING

- A. After completing system installation and testing, adjusting, and balancing AHU and air-distribution systems, clean filter housings and install new filters.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain AHUs. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 237413

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SECTION 23 81 40
AIR-COOLED CONDENSING UNIT

A. PART 1 – GENERAL

0. DESCRIPTION

A. Outdoor-mounted, air-cooled condensing unit with Puron® refrigerant (R-410A) suitable for on-the-ground or rooftop installation. The 38APS unit shall have one refrigeration circuit and shall consist of two or three rotary scroll compressors. The 38APD unit shall have two independent refrigeration circuits and shall consist of two, four, five or six rotary scroll compressors. Unit shall have air-cooled coils, propeller-type condenser fans, a control box, and shall discharge condenser air vertically upward as shown on certified drawings. Unit shall be used in refrigeration circuit with a central station air-handling unit or direct-expansion coils.

1. DEFINITIONS:

B. Coefficient of Performance (COP) - Cooling: The ratio of the rate of heat removed to the rate of energy input in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

C. Energy Efficiency Ratio (EER): The ratio of net cooling capacity is Btu/h to total rate of electricity input in watts under designated operating conditions.

D. Seasonal Energy Efficiency Ratio (SEER) - Total cooling output of an air conditioner during its normal annual usage period for cooling in Btu/h divided by total electric energy input in watts during the same period.

2. QUALITY ASSURANCE:

A. Unit performance shall be rated in accordance with AHRI (Air-Conditioning, Heating, and Refrigeration Institute) Standard 365, latest edition (U.S.A).

B. Unit construction shall comply with latest edition of ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) 15 Safety Code, UL 1995, and ASME (American Society of Mechanical Engineers) applicable codes (U.S.A. codes).

C. The management system governing the manufacturer of the product is ISO (International Organization for Standardization) 9001: 2008 certified.

D. Base unit shall be constructed in accordance with UL (Underwriters Laboratories) standards and CSA (Canadian Standards Association).

E. Unit cabinet shall be capable of withstanding 500-hour salt-spray exposure per ASTM (American Society for Testing and Materials) B117 (scribed specimen).

F. Design pressure shall be 650 psig (4482 kPa).

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- G. Unit shall be functional checked at the factory.
- H. Scheduled performance represents the minimum acceptable level of performance.
- I. Manufacturer shall provide for design of all refrigerant piping systems to include line sizing and refrigerant pressure requirements. Manufacturer shall provide all components as required for reliable operation in long line length applications. It shall be the responsibility of the manufacturer to identify if the maximum distance, both vertical and total distance exceeds the listed limits of the equipment and to provide equipment and components and equipment as required for reliable operation given the length of the refrigerant line runs. Contractor shall submit a refrigerant piping riser diagram compliant with the manufacturers' installation requirements for length and elevation for review by the Engineer.
- J. Unit shall be shipped as single package and shall be stored and handled per unit manufacturer's recommendations.

3. SUBMITTALS

- A. Submit in accordance with specifications.
- B. Manufacturer's Literature and Data:
 - 1. Air-Source Unitary Equipment:
 - a. Split system
- C. Certification: Submit, simultaneously with shop drawings, a proof of certification that this product has been certified by AHRI.
- D. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required cooling and heating capacities EER and COP values as applicable.
- E. Performance information indicated in the equipment schedules shall represent the minimum level of acceptable performance. All submitted equipment shall meet or exceed the stated performance.
- F. Submit wind load pressure calculations for exterior components to demonstrate compliance with the prevailing codes at the time of permit. This shall include unit casing calculations, unit to curb attachment calculations and curb to roof calculations.

PART 2- PRODUCTS

1. UNITARY EQUIPMENT (SPLIT DX SYSTEMS)

A. General:

Factory assembled, single-piece, air-cooled condensing unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressors, nitrogen holding charge, and special features required prior to field start-up.

B. Unit Cabinet:

- 1. Cabinet shall be galvanized steel casing with a baked enamel powder or pre-painted finish.
- 2. Cabinet shall be capable of withstanding 500-hr salt spray test in accordance with ASTM (U.S.A.) B-117 standard.
- 3. Control box access panels shall be hinged for service access.
- 4. Lifting holes shall be provided to facilitate rigging.

C. Fans:

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1. Condenser fans shall be direct-drive propeller type, discharging air vertically upward.
 2. All condenser fan motors shall be totally enclosed 3-phase type with permanently lubricated ball bearings, class F insulation and internal, automatic-reset thermal overload protection or manual reset calibrated circuit breakers.
 3. Shafts shall have inherent corrosion resistance.
 4. Fan blades shall be statically and dynamically balanced.
 5. Condenser-fan openings shall be equipped with PVC-coated steel wire safety guards.
- D. Compressors:
1. Compressors shall be rotary scroll.
 2. Operating oil charge and a crankcase heater control oil dilution.
 3. Compressors shall be mounted on two rails having rubber in shear vibration isolators.
 4. Staging of compressors shall provide unloading capability. Digital compressor unloading control shall be available as an option on one circuit (not available on size 065 unit).
 5. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have either internal line break thermal and current overload protection or external current overload modules with compressor temperature sensors.
- E. Condenser Coils:
1. Coil shall be air-cooled microchannel heat exchanger (MCHX) and shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds. Microchannel coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for the fins, tubes and manifolds in combination with a corrosion-resistant coating on the tubes.
 2. Tubes shall be cleaned, dehydrated, and sealed.
 3. Assembled condenser coils shall be leak tested and pressure tested at 650 psig (4482 kPa).
- F. Refrigeration Components:
1. Refrigeration circuit components shall include liquid line temperature relief device, pressure transducers, liquid line shutoff valve, suction shutoff valve, suction line accumulators, nitrogen holding charge, and compressor oil.
 2. Long line length check valves are required for liquid line installation on all linear line length applications of more than 100 ft (30.5 m) to prevent liquid migration during unit shutdown. For any 025-030 size dual circuit unit application where evaporator is located higher than the condensing unit, check valves are required for linear line length above 55 ft (16.8 m).
 3. Units shall include one factory-installed suction line accumulator for each refrigerant circuit.
- G. Controls and Safeties:
1. Unit *ComfortLink* controls shall include:
 - a. Scrolling marquee display module shall be used for accessing condensing unit information, reading sensor values, and testing the condensing unit. The scrolling marquee display is a 4-key, 4-character, 16-segment LED (light-emitting diode) display. Eleven mode LEDs shall be located on the display as well as an Alarm Status LED. The display shows all of the *ComfortLink* control codes (with 60-character expandable clear language), plus set points, time of day, temperatures, pressures, and superheat. Additional information can be displayed all at once with the accessory Navigator™ display.
 - b. Carrier Comfort Network® (CCN) system capability.
 - c. Unit control with standard pressure transducer, discharge pressure transducer and suction temperature thermistors.
 - d. Current alarm list and alarm history list on display.
 - e. Automatic compressor lead/lag control.

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- f. Service run test capability.
- g. Compressor minimum run time (3 minutes) and minimum off time (3 minutes).
- h. Service diagnostic mode.
- i. Self-contained low voltage control circuit.
- j. Cycle condenser fans to maintain proper head pressure control.
- k. Capacity control with staging compressors.
- 2. Optional digital scrolls to stage compressors and cycle digital compressor for maintaining desired leaving air temperature set point.
 - a. Alarm relay output to indicate when unit is in alarm condition.
- 3. Minimum unit safety devices shall include:
 - a. Solid-state compressor lockout to provide optional reset capability at the space thermostat if any of the following safety devices trip and shut off compressor.
 - b. Compressor lockout protection for internal or external overload.
 - c. Low pressure protection.
 - d. High pressure protection (high pressure switch or internal).
 - e. Compressor reverse rotation protection.
 - f. Loss of charge protection.
 - g. Low suction superheat protection.
 - h. Short cycle protection.
 - i. Suction and discharge pressure transducers.
 - j. Circuit breakers or fuses for short circuit protection of compressors.
- k. Electrical Requirements:
 - i. All unit power wiring shall enter unit cabinet at a single location (115 and 130 size units available with dual point power with terminal block).
 - J. Special Features:
 - 1. Low Ambient Control:
 - a. Control shall regulate fan motor speed in response to the saturated condensing temperature of the unit. The control shall be capable of operating with outdoor temperatures at -20°F (-28.9°C).
 - b. Motormaster® low ambient control shall be available as a factory-installed option or field installed accessory for all units.
 - 2. Optional E-Coated MCHX Condenser Coil:

E-coated aluminum microchannel coils shall have a flexible epoxy polymer coating uniformly applied to all coil external surface areas without material bridging between fins or louvers. Coating process shall ensure complete coil encapsulation, including all exposed fin edges. E-coat thickness of 0.8 to 1.2 mil with top coat having a uniform dry film thickness from 1.0 to 2.0 mil on all external coil surface areas, including fin edges, shall be provided. E-coated coils shall have superior hardness characteristics of 2H per ASTM D3363-00 and cross-hatch adhesion of 4B-5B per ASTM D3359-02. E-coated products shall have superior impact resistance with no cracking, chipping or peeling per NSF/ANSI (National Sanitation Foundation/American National Standards Institute) 51-2002 Method 10.2 (U.S.A. Standards). E-coated aluminum microchannel coils shall be capable of withstanding an 8,000-hour salt spray test in accordance with the ASTM (American Society for Testing and Materials) (U.S.A.) B-117 Standard.
 - 3. Sound Reduction:
 - a. Low sound fan for sound reduction is available as a factory-installed option or field-installed accessory for all units.

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b. Low sound compressor blankets for additional sound reduction are available as a factory-installed option on all units having low sound fans or as a field-installed accessory.

4. Digital Compressor Option:

Modification shall include digital compressor to provide incremental steps for tighter temperature control. The digital compressor shall be available as a factory-installed option for all units except size 065.

5. Non-Fused Disconnect:

A non-fused disconnect is available as a factory-installed option for all units having single point power connection units.

6. Long Line Length Check Valves:

Long line length check valves are available as options shipped with the unit or accessories shipped separately. In either case, field installation is required.

9. BACnet Communication Option:

The BACnet Communication option shall provide factory-installed communication capability with a BACnet MS/TP network. Allows integration with i-Vu® Open control system or a BACnet building automation system.

10. BACnet Translator Control:

BACnet control shall be available as a field-installed accessory for all units to provide interface between unit and a BACnet Local Area Network (LAN, i.e., MS/TP EIA-485).

14. Remote Enhanced Display Accessory Kit:

The remote enhanced display accessory kit shall contain a remotely mounted 40-character per line, 16-line display panel for unit diagnostics.

15. Security Grilles/Hail Guards:

Units shall be supplied with factory-installed or field-installed louvered, sheet metal panels which securely fasten to the unit to provide condenser coil protection against hail and physical damage.

16. Vibration Isolation Pads:

Neoprene vibration isolation pads (24 in. x 3 in. x 1/4 in.) shall be available for field installation to reduce vibration transmission from the compressor through the floor and into the conditioned space.

17. Wind Baffle Kit:

Field-installed accessory kit shall provide wind baffles for use with low ambient temperature operation.

18. Seismic Certification:

A seismic kit is provided which will result in a unit SDS (seismic design acceleration parameter) level of 2.5 for 38AP025-065 units and 2.1 for 38AP070-130 units.

PART 3- EXECUTION

1. INSTALLATION

A. Install split systems and packaged systems according to manufacturers printed instructions.

B. Manufacturer shall provide for design of all refrigerant piping systems to include line sizing and refrigerant pressure requirements. Manufacturer shall provide all components as required for reliable operation in long line length applications. It shall be the responsibility of the manufacturer to identify if the maximum distance, both vertical and total distance exceeds the listed limits of the equipment and to provide equipment and components and equipment as required for reliable operation given the length of the refrigerant line runs.

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- C. Install electrical and control devices furnished by the manufacturer but not specified to be factory mounted. All electrical work shall comply with the electrical specifications
- D. Perform startup checks according to manufacturer's written instructions.
- E. Provide factory start-up for all units. Provide Project Engineer and Commissioning Agent with copies of the factory start-up sheets.
- F. Test controls and demonstrate its compliance with project requirements. Replace damaged or malfunctioning controls and equipment and retest the equipment to the satisfaction of the Project Engineer and Commissioning Agent.
- G. Provide services of manufacturer's technical representative for four hours to instruct owner personnel in operation and maintenance of units.

End of Section

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SECTION 26 05 11

REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 GENERAL

1. DESCRIPTION

- A. This section applies to all sections of Division 26.
- B. Furnish and install electrical systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, conductors and cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on the drawings.
- C. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.
- D. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are prohibited.

2. MINIMUM REQUIREMENTS

- A. The International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), and National Fire Protection Association (NFPA) codes and standards are the minimum requirements for materials and installation.
- B. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above codes and standards.

3. TEST STANDARDS

- A. All materials and equipment shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwriters Laboratories, Inc. (UL), standards where test standards have been established. Materials and equipment which are not covered by UL standards will be accepted, providing that materials and equipment are listed, labeled, certified or otherwise determined to meet the safety requirements of a NRTL. Materials and equipment which no NRTL accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as ANSI, NEMA, and NETA. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:

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1. Listed: Materials and equipment included in a list published by an organization that is acceptable to the Authority Having Jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed materials and equipment or periodic evaluation of services, and whose listing states that the materials and equipment either meets appropriate designated standards or has been tested and found suitable for a specified purpose.

2. Labeled: Materials and equipment to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the Authority Having Jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled materials and equipment, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3. Certified: Materials and equipment which:

a. Have been tested and found by a NRTL to meet nationally recognized standards or to be safe for use in a specified manner.

b. Are periodically inspected by a NRTL.

c. Bear a label, tag, or other record of certification.

4. Nationally Recognized Testing Laboratory: Testing laboratory which is recognized and approved by the Secretary of Labor in accordance with OSHA regulations.

4. QUALIFICATIONS (PRODUCTS AND SERVICES)

A. Manufacturer's Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the materials and equipment specified for this project, and shall have manufactured the materials and equipment for at least three years.

B. Product Qualification:

1. Manufacturer's materials and equipment shall have been in satisfactory operation, on three installations of similar size and type as this project, for at least three years.

2. The Owner reserves the right to require the Contractor to submit a list of installations where the materials and equipment have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within eight hours of receipt of notification that service is needed. Submit name and address of service organizations.

5. APPLICABLE PUBLICATIONS

A. Applicable publications listed in all Sections of Division 26 are the latest issue, unless otherwise noted.

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B. Products specified in all sections of Division 26 shall comply with the applicable publications listed in each section.

6. MANUFACTURED PRODUCTS

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available.

B. When more than one unit of the same class or type of materials and equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer.

2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

3. Components shall be compatible with each other and with the total assembly for the intended service.

4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory wiring and terminals shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Testing Is Specified:

1. The Owner shall have the option of witnessing factory tests. The Contractor shall notify the Owner a minimum of 15 working days prior to the manufacturer's performing the factory tests.

2. Four copies of certified test reports shall be furnished to the Owner two weeks prior to final inspection and not more than 90 days after completion of the tests.

3. When materials and equipment fail factory tests, and re-testing and re-inspection is required, the Contractor shall be liable for all additional expenses for the Owner to witness re-testing.

7. VARIATIONS FROM CONTRACT REQUIREMENTS

A. Where the Owner or the Contractor requests variations from the contract requirements, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

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8. MATERIALS AND EQUIPMENT PROTECTION

A. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.

1. Store materials and equipment indoors in clean dry space with uniform temperature to prevent condensation.

2. During installation, equipment shall be protected against entry of foreign matter, and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.

3. Damaged equipment shall be repaired or replaced, as determined by the Owner.

4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.

5. Damaged paint on equipment shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

9. WORK PERFORMANCE

A. All electrical work shall comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J – General Environmental Controls, OSHA Part 1910 subpart K – Medical and First Aid, and OSHA Part 1910 subpart S – Electrical, in addition to other references required by contract.

B. Job site safety and worker safety is the responsibility of the Contractor.

C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:

1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.

2. Before initiating any work, a job specific work plan must be developed by the Contractor with a peer review conducted and documented by Owner. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used, and exit pathways.

3. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the Owner.

D. For work that affects existing electrical systems, arrange, phase and perform work to assure minimal interference with normal functioning of the facility.

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E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions.

F. Coordinate location of equipment and conduit with other trades to minimize interference.

10. EQUIPMENT INSTALLATION AND REQUIREMENTS

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working clearances shall not be less than specified in the NEC.

C. Inaccessible Equipment:

1. Where the Owner determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Owner.

2. "Readily accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

D. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.

11. EQUIPMENT IDENTIFICATION

A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers, fused and non-fused safety switches, generators, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.

B. Identification signs for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Identification signs for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 12 mm (1/2 inch) high. Identification signs shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.

C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall indicate the arc hazard boundary (inches), working distance (inches), arc flash incident energy at the working distance (calories/cm²), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches),

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restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

12. SUBMITTALS

A. Submit to the Owner.

B. The Owner's approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or installation of materials and equipment which has not had prior approval will not be permitted.

C. All submittals shall include six copies of adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the Owner to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and equipment being submitted.

D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.

1. Mark the submittals, "SUBMITTED UNDER SECTION _____".

2. Submittals shall be marked to show specification reference including the section and paragraph numbers.

3. Submit each section separately.

E. The submittals shall include the following:

1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, manuals, pictures, nameplate data, and test reports as required.

2. Submittals are required for all equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion, etc.) associated with equipment or piping so that the proposed installation can be properly reviewed. Include sufficient fabrication information so that appropriate mounting and securing provisions may be designed and attached to the equipment.//

3. Elementary and interconnection wiring diagrams for communication and signal systems, control systems, and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.

a. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.

F. Maintenance and Operation Manuals:

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1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the material or equipment.
3. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.
 - c. Description of the function of each principal item of equipment.
 - d. Installation instructions.
 - e. Safety precautions for operation and maintenance.
 - f. Diagrams and illustrations.
 - g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare and replacement parts, and name of servicing organization.
 - j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.
- G. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.
- H. After approval and prior to installation, furnish the Owner with one sample of each of the following:

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1. A minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the coils or reels from which the sample was taken. The length of the sample shall be sufficient to show all markings provided by the manufacturer.
2. Each type of conduit coupling, bushing, and termination fitting.
3. Conduit hangers, clamps, and supports.
4. Duct sealing compound.
5. Each type of receptacle, toggle switch, lighting control sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

13. SINGULAR NUMBER

- A. Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

14. POLYCHLORINATED BIPHENYL (PCB) EQUIPMENT

- A. This project requires the removal, transport, and disposal of electrical equipment containing Polychlorinated Biphenyls (PCB) in accordance with the Federal Toxic Substances Control Act (TSCA).
- B. The equipment to be removed is shown on the drawings.
- C. The selective demolition shall be in accordance with Section 02 41 00, DEMOLITION.

15. ACCEPTANCE CHECKS AND TESTS

- A. The Contractor shall furnish the instruments, materials, and labor for tests.
- B. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer's representatives and technicians so that a complete, functional, and operational system is delivered to the Owner.
- C. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests. Repair, replacement, and retesting shall be accomplished at no additional cost to the Owner.

16. WARRANTY

- A. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Contracting Officer for the Owner.

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17. INSTRUCTION

A. Instruction to designated Owner personnel shall be provided for the particular equipment or system as required in each associated technical specification section.

B. Furnish the services of competent instructors to give full instruction in the adjustment, operation, and maintenance of the specified equipment and system, including pertinent safety requirements. Instructors shall be thoroughly familiar with all aspects of the installation, and shall be trained in operating theory as well as practical operation and maintenance procedures.

C. A training schedule shall be developed and submitted by the Contractor and approved by the Owner at least 30 days prior to the planned training.

End of Section

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1. DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

2. QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

3. FACTORY TESTS

A. Conductors and cables shall be thoroughly tested at the factory per NEMA to ensure that there are no electrical defects. Factory tests shall be certified.

4. SUBMITTALS

A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:

a. Submit sufficient information to demonstrate compliance with drawings and specifications.

b. Submit the following data for approval:

1) Electrical ratings and insulation type for each conductor and cable.

2) Splicing materials and pulling lubricant.

2. Certifications: Two weeks prior to final inspection, submit the following.

a. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.

b. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested.

5. APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.

B. American Society of Testing Material (ASTM):

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- D2301-10 Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
- D2304-10 Test Method for Thermal Endurance of Rigid Electrical Insulating Materials
- D3005-10 Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

C. National Electrical Manufacturers Association (NEMA):

WC 70-09 Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy

D. National Fire Protection Association (NFPA):

70-11 National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):

44-10 Thermoset-Insulated Wires and Cables

83-08 Thermoplastic-Insulated Wires and Cables

467-07 Grounding and Bonding Equipment

486A-486B-03 Wire Connectors

486C-04 Splicing Wire Connectors

486D-05 Sealed Wire Connector Systems

486E-09 Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

493-07 Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables

514B-04 Conduit, Tubing, and Cable Fittings

PART 2 PRODUCTS

1. CONDUCTORS AND CABLES

A. Conductors and cables shall be in accordance with NEMA, UL, as specified herein, and as shown on the drawings.

B. All conductors shall be copper.

C. Single Conductor and Cable:

1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.

2. No. 8 AWG and larger: Stranded.

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3. No. 10 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.
4. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.
- D. Direct Burial Cable: UF or USE cable.
- E. Color Code:
 1. No. 10 AWG and smaller: Solid color insulation or solid color coating.
 2. No. 8 AWG and larger: Color-coded using one of the following methods:
 - a. Solid color insulation or solid color coating.
 - b. Stripes, bands, or hash marks of color specified.
 - c. Color using 19 mm (0.75 inches) wide tape.
 3. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
 4. Conductors shall be color-coded as follows:

208/120 V	Phase	480/277 V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

5. Lighting circuit "switch legs", and 3-way and 4-way switch "traveling wires," shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC.
6. Color code for isolated power system wiring shall be in accordance with the NEC.
2. SPLICES
 - A. Splices shall be in accordance with NEC and UL.
 - B. Above Ground Splices for No. 10 AWG and Smaller:
 1. Solderless, screwon, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.

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2. The integral insulator shall have a skirt to completely cover the stripped conductors.
 3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.
- C. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:
1. Compression, hex screw, or bolt clamp type of high conductivity and corrosion resistant material, listed for use with copper and aluminum conductors.
 2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
 3. Splice and insulation shall be product of the same manufacturer.
 4. All bolts, nuts, and washers used with splices shall be zinc-plated, cadmium-plated steel.
- D. Above Ground Splices for 250 kcmil and Larger:
1. Long barrel "butt-splice" or "sleeve" type compression connectors, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
 2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
 3. Splice and insulation shall be product of the same manufacturer.
- E. Underground Splices for No. 10 AWG and Smaller:
1. Solderless, screw on, reusable pressure cable type, with integral insulation. Listed for wet locations, and approved for copper and aluminum conductors.
 2. The integral insulator shall have a skirt to completely cover the stripped conductors.
 3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.
- F. Underground Splices for No. 8 AWG and Larger:
1. Mechanical type, of high conductivity and corrosion resistant material. Listed for wet locations, and approved for copper and aluminum conductors.
 2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
 3. Splice and insulation shall be product of the same manufacturer.
- G. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

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3. CONNECTORS AND TERMINATIONS

- A. Mechanical type of high conductivity and corrosionresistant material, listed for use with copper and aluminum conductors.
- B. Long barrel compression type of high conductivity and corrosionresistant material, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
- C. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be zinc-plated, cadmium-plated steel.

4. CONTROL WIRING

- A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG.
- B. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

5. WIRE LUBRICATING COMPOUND

- A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.
- B. Shall not be used on conductors for isolated power systems.

PART 3 EXECUTION

1. GENERAL

- A. Install conductors in accordance with the NEC, as specified, and as shown on the drawings.
- B. Install all conductors in raceway systems.
- C. Splice conductors only in outlet boxes, junction boxes, pullboxes, manholes, or handholes.
- D. Conductors of different systems (e.g., 120 V and 277 V) shall not be installed in the same raceway.
- E. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
- F. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic ties.
- G. For connections to motors, transformers, and vibrating equipment, stranded conductors shall be used only from the last fixed point of connection to the motors, transformers, or vibrating equipment.
- H. Use expanding foam or non-hardening duct-seal to seal conduits entering a building, after installation of conductors.
- I. Conductor and Cable Pulling:

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1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.
2. Use nonmetallic pull ropes.
3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
4. All conductors in a single conduit shall be pulled simultaneously.
5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- J. No more than three branch circuits shall be installed in any one conduit.
- K. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

2. **SPLICE AND TERMINATION INSTALLATION**

- A. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer's published torque values using a torque screwdriver or wrench.
- B. Where the Owner determines that unsatisfactory splices or terminations have been installed, replace the splices or terminations at no additional cost to the Owner.

3. **CONDUCTOR IDENTIFICATION**

- A. When using colored tape to identify phase, neutral, and ground conductors larger than No. 8 AWG, apply tape in half-overlapping turns for a minimum of 75 mm (3 inches) from terminal points, and in junction boxes, pullboxes, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable, stating size and insulation type.

4. **FEEDER CONDUCTOR IDENTIFICATION**

- A. In each interior pullbox, install brass tags on all feeder conductors to clearly designate their circuit identification and voltage. The tags shall be the embossed type, 40 mm (1-1/2 inches) in diameter and 40 mils thick. Attach tags with plastic ties.

5. **EXISTING CONDUCTORS**

- A. Unless specifically indicated on the plans, existing conductors shall not be reused.

6. **CONTROL WIRING INSTALLATION**

- A. Unless otherwise specified in other sections, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.
- B. Install a separate power supply circuit for each system, except where otherwise shown on the drawings.

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7. CONTROL WIRING IDENTIFICATION

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.

8. ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
 - 1. Visual Inspection and Tests: Inspect physical condition.
 - 2. Electrical tests:
 - a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
 - b. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.
 - c. Perform phase rotation test on all three-phase circuits.

End of Section

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1. DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.
- B. "Grounding electrode system" refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this section and have the same meaning.

2. QUALITY ASSURANCE

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

3. SUBMITTALS

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:

- a. Submit sufficient information to demonstrate compliance with drawings and specifications.
- b. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.

2. Test Reports:

- a. Two weeks prior to the final inspection, submit ground resistance field test reports to the Owner.

3. Certifications:

- a. Certification by the Contractor that the grounding equipment has been properly installed and tested.

4. APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

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B. American Society for Testing and Materials (ASTM):

- | | |
|-------|--|
| B1-07 | Standard Specification for Hard-Drawn Copper Wire |
| B3-07 | Standard Specification for Soft or Annealed Copper Wire |
| B8-11 | Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

- | | |
|-------|---|
| 81-83 | IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements |
|-------|---|

D. National Fire Protection Association (NFPA):

- | | |
|--------|---------------------------------|
| 70-11 | National Electrical Code (NEC) |
| 70E-12 | National Electrical Safety Code |

E. Underwriters Laboratories, Inc. (UL):

- | | |
|--------|---|
| 44-10 | ThermosetInsulated Wires and Cables |
| 83-08 | ThermoplasticInsulated Wires and Cables |
| 467-07 | Grounding and Bonding Equipment |

PART 2 PRODUCTS

1. GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.

B. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.

C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

D. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

2. GROUND RODS

A. Steel or copper clad steel, Stainless steel, 19 mm (0.75 inch) diameter by 3 M (10 feet) long.

B. Quantity of rods shall be as shown on the drawings, and as required to obtain the specified ground resistance.

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3. CONCRETE ENCASED ELECTRODE

- A. Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

4. GROUND CONNECTIONS

- A. Below Grade and Inaccessible Locations: Exothermic-welded type connectors.

- B. Above Grade:

- 1. Bonding Jumpers: Listed for use with aluminum and copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs shall use zinc-plated, cadmium-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

- 2. Connection to Building Steel: Exothermic-welded type connectors.

- 3. Connection to Grounding Bus Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated, cadmium-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

- 4. Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated, cadmium-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

5. EQUIPMENT RACK AND CABINET GROUND BARS

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks. Ground bars shall have minimum dimensions of 6.3 mm (0.25 inch) thick x 19 mm (0.75 inch) wide, with length as required or as shown on the drawings. Provide insulators and mounting brackets.

6. GROUND TERMINAL BLOCKS

- A. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide mechanical type lugs, with zinc-plated, cadmium-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

7. GROUNDING BUS BAR

- A. Pre-drilled rectangular copper bar with stand-off insulators, minimum 6.3 mm (0.25 inch) thick x 100 mm (4 inches) high in cross-section, length as shown on the drawings, with hole size, quantity, and spacing per detail shown on the drawings. Provide insulators and mounting brackets.

PART 3 EXECUTION

1. GENERAL

- A. Install grounding equipment in accordance with the NEC, as shown on the drawings, and as specified herein.

- B. System Grounding:

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1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformer.
2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
3. Isolation transformers and isolated power systems shall not be system grounded.
- C. Equipment Grounding: Metallic piping, building structural steel, electrical enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.
- D. For patient care area electrical power system grounding, conform to NFPA 99 and NEC.
2. INACCESSIBLE GROUNDING CONNECTIONS
 - A. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.
3. SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS
 - A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
 - B. Metallic Piping, Building Structural Steel, and Supplemental Electrode(s):
 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building structural steel, and supplemental or made electrodes. Provide jumpers across insulating joints in the metallic piping.
 2. Provide a supplemental ground electrode as shown on the drawings and bond to the grounding electrode system.
 - C. Switchgear, Switchboards, Unit Substations, Panelboards, Motor Control Centers, Engine-Generators, Automatic Transfer Switches, and other electrical equipment:
 1. Connect the equipment grounding conductors to the ground bus.
 2. Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.
4. RACEWAY
 - A. Conduit Systems:
 1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
 2. Nonmetallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.

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3. Metallic conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.

4. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a equipment grounding conductor to the equipment ground bus.

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and power and lighting branch circuits.

C. Boxes, Cabinets, Enclosures, and Panelboards:

1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).

2. Provide lugs in each box and enclosure for equipment grounding conductor termination.

D. Wireway Systems:

1. Bond the metallic structures of wireway to provide electrical continuity throughout the wireway system, by connecting a No. 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.

2. Install insulated No. 6 AWG bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 16 M (50 feet).

3. Use insulated No. 6 AWG bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.

4. Use insulated No. 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 M (49 feet).

E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.

F. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

H. Raised Floors: Provide bonding for all raised floor components as shown on the drawings.

I. Panelboard Bonding in Patient Care Areas: The equipment grounding terminal buses of the normal and essential branch circuit panel boards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than No. 10 AWG, installed in rigid metal conduit.

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5. OUTDOOR METALLIC FENCES AROUND ELECTRICAL EQUIPMENT

A. Fences shall be grounded as shown on the drawings. Fences shall be grounded with a ground rod at each fixed gate post and at each corner post.

B. Drive ground rods until the top is 300 mm (12 inches) below grade. Attach a No. 4 AWG copper conductor by exothermic weld to the ground rods, and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 300 mm (12 inches) of fence mesh and fasten by two approved bronze compression fittings, one to bond the wire to post and the other to bond the wire to fence. Each gate section shall be bonded to its gatepost by a 3 mm x 25 mm (0.375 inch x 1 inch) flexible, braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

6. CORROSION INHIBITORS

A. When making grounding and bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

7. CONDUCTIVE PIPING

A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

8. GROUND RESISTANCE

A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Owner. Final tests shall ensure that this requirement is met.

B. Grounding system resistance shall comply with the electric utility company ground resistance requirements.

9. ACCEPTANCE CHECKS AND TESTS

A. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized or connected to the electric utility company ground system, and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall.

B. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

End of Section

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SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1. DESCRIPTION

A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes, to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.

B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

2. QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

3. SUBMITTALS

In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

A. Manufacturer's Literature and Data: Showing each cable type and rating. The specific item proposed and its area of application shall be identified on the catalog cuts.

B. Shop Drawings:

1. Size and location of main feeders.
2. Size and location of panels and pull-boxes.
3. Layout of required conduit penetrations through structural elements.

C. Certifications:

1. Two weeks prior to the final inspection, submit four copies of the following certifications to the Owner:
 - a. Certification by the manufacturer that the material conforms to the requirements of the drawings and specifications.
 - b. Certification by the contractor that the material has been properly installed.

4. APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

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B. American National Standards Institute (ANSI):

C80.1-05	Electrical Rigid Steel Conduit
C80.3-05	Steel Electrical Metal Tubing
C80.6-05	Electrical Intermediate Metal Conduit

C. National Fire Protection Association (NFPA):

70-08	National Electrical Code (NEC)
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D. Underwriters Laboratories, Inc. (UL):

1-05	Flexible Metal Conduit
5-04	Surface Metal Raceway and Fittings
6-07	Electrical Rigid Metal Conduit - Steel
50-95	Enclosures for Electrical Equipment
360-093	Liquid-Tight Flexible Steel Conduit
467-07	Grounding and Bonding Equipment
514A-04	Metallic Outlet Boxes
514B-04	Conduit, Tubing, and Cable Fittings
514C-96	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
651-05	Schedule 40 and 80 Rigid PVC Conduit and Fittings
651A-00	Type EB and A Rigid PVC Conduit and HDPE Conduit
797-07	Electrical Metallic Tubing
1242-06	Electrical Intermediate Metal Conduit - Steel

E. National Electrical Manufacturers Association (NEMA):

TC-2-03	Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
TC-3-04	PVC Fittings for Use with Rigid PVC Conduit and Tubing
FB1-07 Metallic Tubing and Cable	Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical

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PART 2 PRODUCTS

1. MATERIAL

A. Conduit Size: In accordance with the NEC, but not less than 0.5 in [13 mm] unless otherwise shown. Where permitted by the NEC, 0.5 in [13 mm] flexible conduit may be used for tap connections to recessed lighting fixtures.

B. Conduit:

1. Rigid steel: Shall conform to UL 6 and ANSI C80.1.
2. Rigid intermediate steel conduit (IMC): Shall conform to UL 1242 and ANSI C80.6.
3. Electrical metallic tubing (EMT): Shall conform to UL 797 and ANSI C80.3. Maximum size not to exceed 4 in [105 mm] and shall be permitted only with cable rated 600 V or less.
4. Flexible galvanized steel conduit: Shall conform to UL 1.
5. Liquid-tight flexible metal conduit: Shall conform to UL 360.
6. Surface metal raceway: Shall conform to UL 5.

C. Conduit Fittings:

1. Rigid steel and IMC conduit fittings:
 - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
 - b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
 - c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
 - d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - e. Erickson (union type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
 - f. Sealing fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
2. Electrical metallic tubing fittings:
 - a. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.

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- c. Compression couplings and connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
- d. Setscrew couplings and connectors: Use setscrews of case-hardened steel with hex head and cup point, to firmly seat in wall of conduit for positive grounding.
- e. Indent-type connectors or couplings are prohibited.
- f. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
- 3. Flexible steel conduit fittings:
 - a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
 - b. Clamp-type, with insulated throat.
- 4. Liquidtight flexible metal conduit fittings:
 - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- 5. Surface metal raceway fittings: As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, conduit entry fittings, accessories, and other fittings as required for complete system.
- 6. Expansion and deflection couplings:
 - a. Conform to UL 467 and UL 514B.
 - b. Accommodate a 0.75 in [19 mm] deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
 - c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
 - d. Jacket: Flexible, corrosionresistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.
- D. Conduit Supports:
 - 1. Parts and hardware: Zinccoat or provide equivalent corrosion protection.
 - 2. Individual Conduit Hangers: Designed for the purpose, having a preassembled closure bolt and nut, and provisions for receiving a hanger rod.
 - 3. Multiple conduit (trapeze) hangers: Not less than 1.5 x 1.5 in [38 mm x 38 mm], 12-gauge steel, cold-formed, lipped channels; with not less than 0.375 in [9 mm] diameter steel hanger rods.

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4. Solid Masonry and Concrete Anchors: Selfdrilling expansion shields, or machine bolt expansion.
- E. Outlet, Junction, and Pull Boxes:
 1. UL-50 and UL-514A.
 2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
 3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
 4. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.
- F. Wireways: Equip with hinged covers, except where removable covers are shown. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

PART 3 EXECUTION

1. PENETRATIONS

A. Cutting or Holes:

1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the Owner prior to drilling through structural elements.
 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except where permitted by the Owner as required by limited working space.
- B. Firestop:** Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases.
- C. Waterproofing:** At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight.

2. INSTALLATION, GENERAL

- A.** In accordance with UL, NEC, as shown, and as specified herein.
- B.** Essential (Emergency) raceway systems shall be entirely independent of other raceway systems, except where shown on drawings.
- C.** Install conduit as follows:
1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
 2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.

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3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
 4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
 5. Cut square, ream, remove burrs, and draw up tight.
 6. Independently support conduit at 8 ft [2.4 M] on centers. Do not use other supports, i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts.
 7. Support within 12 in [300 mm] of changes of direction, and within 12 in [300 mm] of each enclosure to which connected.
 8. Close ends of empty conduit with plugs or caps at the roughin stage until wires are pulled in, to prevent entry of debris.
 9. Conduit installations under fume and vent hoods are prohibited.
 10. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
 11. Flashing of penetrations of the roof membrane.
 12. Conduit bodies shall only be used for changes in direction, and shall not contain splices.
 13. Do not use aluminum conduits in wet locations.
- D. Conduit Bends:
1. Make bends with standard conduit bending machines.
 2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
 3. Bending of conduits with a pipe tee or vise is prohibited.
- E. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown on drawings.
 2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Owner.
3. CONCEALED WORK INSTALLATION
- A. In Concrete:
1. Conduit: Rigid steel, IMC, or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
 2. Align and run conduit in direct lines.

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3. Install conduit through concrete beams only:
 - a. Where shown on the structural drawings.
 - b. As approved by the Owner prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 3 in [75 mm] thick is prohibited.
 - a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
 - b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
 - c. Install conduits approximately in the center of the slab so that there will be a minimum of 0.75 in [19 mm] of concrete around the conduits.
5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.
- B. Above Furred or Suspended Ceilings and in Walls:
 1. Conduit for conductors above 600 V: Rigid steel or rigid aluminum. Mixing different types of conduits indiscriminately in the same system is prohibited.
 2. Conduit for conductors 600 V and below: Rigid steel, IMC, rigid aluminum, or EMT. Mixing different types of conduits indiscriminately in the same system is prohibited.
 3. Align and run conduit parallel or perpendicular to the building lines.
 4. Connect recessed lighting fixtures to conduit runs with maximum 6 ft [1.8 M] of flexible metal conduit extending from a junction box to the fixture.
 5. Tightening setscrews with pliers is prohibited.
4. EXPOSED WORK INSTALLATION
 - A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
 - B. Conduit for Conductors above 600 V: Rigid steel or rigid aluminum. Mixing different types of conduits indiscriminately in the system is prohibited.
 - C. Conduit for Conductors 600 V and Below: Rigid steel, IMC, rigid aluminum, or EMT. Mixing different types of conduits indiscriminately in the system is prohibited.
 - D. Align and run conduit parallel or perpendicular to the building lines.
 - E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
 - F. Support horizontal or vertical runs at not over 8 ft [2.4 M] intervals.

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G. Surface metal raceways: Use only where shown.

H. Painting:

1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.

2. Paint all conduits containing cables rated over 600 V safety orange. In addition, paint legends, using 2 in [50 mm] high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 20 ft [6 M] intervals in between.

5. HAZARDOUS LOCATIONS

A. Use rigid steel conduit only, notwithstanding requirements otherwise specified in this or other sections of these specifications.

B. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

6. WET OR DAMP LOCATIONS

A. Unless otherwise shown, use conduits of rigid steel or IMC.

B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.

C. Unless otherwise shown, use rigid steel or IMC conduit within 5 ft [1.5 M] of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.

7. MOTORS AND VIBRATING EQUIPMENT

A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.

B. Use liquidtight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray washdown operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water. Provide a green equipment grounding conductor with flexible metal conduit.

8. EXPANSION JOINTS

A. Conduits 3 in [75 mm] and larger that are secured to the building structure on opposite sides of a building expansion joint require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

B. Provide conduits smaller than 3 in [75 mm] with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 5 in [125 mm] vertical drop midway between the ends. Flexible conduit shall have a bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for conduits 15 in [375 mm] and larger are acceptable.

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C. Install expansion and deflection couplings where shown.

D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 15 in [375 mm] of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

9. CONDUIT SUPPORTS, INSTALLATION

A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits.

C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 200 lbs [90 kg]. Attach each conduit with Ubolts or other approved fasteners.

D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling Tbars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:

1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.

2. Existing Construction:

a. Steel expansion anchors not less than 0.25 in [6 mm] bolt size and not less than 1.125 in [28 mm] embedment.

b. Power set fasteners not less than 0.25 in [6 mm] diameter with depth of penetration not less than 3 in [75 mm].

c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts.

G. Bolts supported only by plaster or gypsum wallboard are not acceptable.

H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.

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L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

10. BOX INSTALLATION

A. Boxes for Concealed Conduits:

1. Flush-mounted.

2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

D. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 24 in [600 mm] center-to-center lateral spacing shall be maintained between boxes.

E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 in [100 mm] square x 2.125 in [55 mm] deep, with device covers for the wall material and thickness involved.

F. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIGFA JB No. 1."

G. On all branch circuit junction box covers, identify the circuits with black marker.

End of Section

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SECTION 26 27 26 WIRING DEVICES

PART 1 GENERAL

1. DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of wiring devices.

2. QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

3. SUBMITTALS

A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:

a. Submit sufficient information to demonstrate compliance with drawings and specifications.

b. Include electrical ratings, dimensions, mounting details, construction materials, grade, and termination information.

2. Manuals:

a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets and information for ordering replacement parts.

b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.

a. Certification by the manufacturer that the wiring devices conform to the requirements of the drawings and specifications.

b. Certification by the Contractor that the wiring devices have been properly installed and adjusted.

4. APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B. National Fire Protection Association (NFPA):

70-11 National Electrical Code (NEC)

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C. National Electrical Manufacturers Association (NEMA):

WD 1-10 General Color Requirements for Wiring Devices

WD 6-08 Wiring Devices – Dimensional Specifications

D. Underwriter's Laboratories, Inc. (UL):

20-10 General-Use Snap Switches

231-07 Power Outlets

467-07 Grounding and Bonding Equipment

498-07 Attachment Plugs and Receptacles

943-11 Ground-Fault Circuit-Interrupters

PART 2 PRODUCTS

1. **TOGGLE SWITCHES**

A. Toggle switches shall be totally enclosed tumbler type with nylon bodies. Handles color shall be as per Owner/Architect unless otherwise specified or shown on the drawings.

1. Switches installed in hazardous areas shall be explosion-proof type in accordance with the NEC and as shown on the drawings.

2. Shall be single unit toggle, butt contact, quiet AC type, heavyduty general-purpose use with an integral self grounding mounting strap with break-off plaster ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.

3. Switches shall be rated 20 amperes at 120-277 Volts AC.

2. **WALL PLATES**

A. Wall plates for switches and receptacles shall be type 302 stainless steel or smooth nylon. Oversize plates are not acceptable.

B. Color shall be as per Owner/Architect.

C. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.

D. In areas requiring tamperproof wiring devices, wall plates shall be type 302 stainless steel, and shall have tamperproof screws and beveled edges.

PART 3 EXECUTION

3. **INSTALLATION**

A. Installation shall be in accordance with the NEC and as shown as on the drawings.

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- B. Install wiring devices after wall construction and painting is complete.
- C. The ground terminal of each wiring device shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the branch circuit equipment grounding conductor.
- D. Provide barriers in multigang outlet boxes to comply with the NEC.
- E. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.
- F. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades.
- G. Install wall switches 1.2 M (48 inches) above floor, with the toggle OFF position down.
- H. When required or recommended by the manufacturer, use a torque screwdriver. Tighten unused terminal screws.
- I. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

4. ACCEPTANCE CHECKS AND TESTS

- A. Perform manufacturer's required field checks in accordance with the manufacturer's recommendations. In addition, include the following:
 - 1. Visual Inspection and Tests:
 - a. Inspect physical and electrical condition.
 - b. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

End of Section

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SECTION 26 29 21 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

1. PART 1 - GENERAL

1. DESCRIPTION

A. This section specifies the furnishing, installation, and connection of fused and unfused disconnect switches (indicated as switches in this section), and separately-enclosed circuit breakers for use in electrical systems rated 600 V and below.

2. QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

3. SUBMITTALS

A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:

a. Submit sufficient information to demonstrate compliance with drawings and specifications.

b. Submit the following data for approval:

1) Electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, fuses, circuit breakers, wiring and connection diagrams, accessories, and device nameplate data.

c. Certification from the manufacturer that representative enclosed switches and circuit breakers have been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.

2. Manuals:

a. Submit complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering fuses, circuit breakers, and replacement parts.

1) Include schematic diagrams, with all terminals identified, matching terminal identification in the enclosed switches and circuit breakers.

2) Include information for testing, repair, troubleshooting, assembly, and disassembly.

b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.

a. Certification by the manufacturer that the enclosed switches and circuit breakers conform to the requirements of the drawings and specifications.

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b. Certification by the Contractor that the enclosed switches and circuit breakers have been properly installed, adjusted, and tested.

4. APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. International Code Council (ICC):

IBC-12 International Building Code

. National Electrical Manufacturers Association (NEMA):

FU I-07 Low Voltage Cartridge Fuses

KS I-06 Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

A. National Fire Protection Association (NFPA):

70-11 National Electrical Code (NEC)

B. Underwriters Laboratories, Inc. (UL):

98-07 Enclosed and Dead-Front Switches

248-00 Low Voltage Fuses

489-09 Molded Case Circuit Breakers and Circuit Breaker Enclosures

PART 2 - PRODUCTS

1. FUSED SWITCHES RATED 600 AMPERES AND LESS

A. Switches shall be in accordance with NEMA, NEC, UL, as specified, and as shown on the drawings.

B. Shall be NEMA classified General Duty (GD) for 240 V switches, and NEMA classified Heavy Duty (HD) for 480 V switches.

C. Shall be horsepower (HP) rated.

D. Shall have the following features:

1. Switch mechanism shall be the quick-make, quick-break type.

2. Copper blades, visible in the open position.

3. An arc chute for each pole.

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4. External operating handle shall indicate open and closed positions, and have lockopen padlocking provisions.
5. Mechanical interlock shall permit opening of the door only when the switch is in the open position, defeatable to permit inspection.
6. Fuse holders for the sizes and types of fuses specified.
7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
8. Ground lugs for each ground conductor.
9. Enclosures:
 - a. Shall be the NEMA types shown on the drawings.
 - b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions.
 - c. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel.
2. NON-FUSED SWITCHES RATED 600 AMPERES AND LESS
 - A. Shall be the same as fused switches, but without provisions for fuses.
3. MOTOR RATED TOGGLE SWITCHES
 - A. Type 1, general purpose for single-phase motors rated up to 1 horsepower.
 - B. Quick-make, quick-break toggle switch with external reset button and thermal overload protection matched to nameplate full-load current of actual protected motor.
4. CARTRIDGE FUSES
 - A. Shall be in accordance with NEMA FU 1.
 - B. Feeders: Class L, fast acting, Class L, time delay, Class RK1, fast acting, Class RK1, time delay, Class RK5, fast acting, Class RK5, time delay, Class J, fast acting, Class J, time delay.
 - C. Motor Branch Circuits: Class RK1, Class RK5, time delay.
 - D. Other Branch Circuits: Class RK1, time delay, Class RK5, time delay, Class J, fast acting, Class J, time delay.
 - E. Control Circuits: Class CC, fast acting, time delay.
5. SEPARATELY-ENCLOSED CIRCUIT BREAKERS
 - A. Provide circuit breakers in accordance with the applicable requirements in Section 26 24 16, PANELBOARDS.

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B. Enclosures shall be the NEMA types shown on the drawings. Where the types are not shown, they shall be the NEMA type most suitable for the ambient environmental conditions.

PART 3 - EXECUTION

1. INSTALLATION

A. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.

B. In seismic areas, enclosed switches and circuit breakers shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.

C. C. Fused switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuses.

2. ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:

- a. Compare equipment nameplate data with specifications and approved shop drawings.
- b. Inspect physical, electrical, and mechanical condition.
- c. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.
- d. Vacuum-clean enclosure interior. Clean enclosure exterior.

3. SPARE PARTS

A. Two weeks prior to the final inspection, furnish one complete set of spare fuses for each fused disconnect switch installed on the project. Deliver the spare fuses to the Owner.

End of Section