

Agreement for Construction Services

This Agreement (“Agreement”) between Williamson County, Texas, a political subdivision of the State of Texas (“Owner”) and The Brandt Companies, LLC (“Contractor”) is entered into in accordance with the following terms and conditions:

ARTICLE 1 SCOPE OF WORK: The Owner desires to retain Contractor for the construction of Emergency Service Operations Center (ESOC) Data Center Computer Room Air conditioning (CRAC) Unit (hereinafter called the “Project”). The Contractor shall have the overall responsibility for and shall provide complete construction services and furnish all materials, equipment, tools and labor as necessary or reasonably inferable to complete the Project, or any phase of the Project, in accordance with the Owner’s requirements and the terms of this Agreement (hereinafter collectively referred to as the “Work”).

ARTICLE 2 CONTRACT PRICE: Owner agrees to pay to the Contractor, for the satisfactory performance of the Work, the sum of Two Million Two Hundred Nine Thousand Six Hundred Eighty-Nine and No/100 Dollars (\$ 2,209,689.00) in accordance with the terms and conditions of this Agreement.

ARTICLE 3 PLANS AND SPECIFICATIONS: The Work shall be performed pursuant to and in accordance with the plans and specifications attached hereto as **Exhibit “A”**, as well as any revisions made thereto.

ARTICLE 4 CONTRACT TIME:

4.1 Contractor shall commence the Work upon instruction to do so from the Owner and shall achieve Substantial Completion within Three Hundred Sixty-five (365) calendar days from the date the Work is commenced; provided, however, Owner may extend said time period in the event bad weather affects the progress of the Work. Unless otherwise specified in writing, Contractor shall achieve Final Completion within Thirty (30) calendar days of Substantial Completion. Owner shall determine when the Project has been fully and finally completed to its satisfaction. The time set forth for completion of the work is an essential element of the Agreement.

4.2 Liquidated Damages.

Contractor acknowledges and recognizes that Owner is entitled to full and beneficial occupancy and use of the completed Work following expiration of the Contract Time and that Owner has

entered into, or will enter into, binding agreements upon Contractor's achieving Substantial Completion of the Work within the Contract Time. Contractor further acknowledges and agrees that if Contractor fails to complete substantially or cause the Substantial Completion of any Phase of the Work within the Contract Time, Owner will sustain extensive damages and serious loss as a result of such failure. In the cases of missed scheduled events, which incur exact losses of revenue and exact expenses for fees and other cancellation costs, Contractor shall be responsible for the exact amount of damages sustained by Owner. In other cases, the exact amount of such damages will be extremely difficult to ascertain. Therefore, Owner and Contractor agree as set forth below:

- 4.2.1** Subject to the other terms and conditions herein, if Substantial Completion is not achieved by the date specified above or by such date to which the Contract Time may be extended, the Contract Price shall be reduced by **Seven Hundred Fifty and No/100 Dollars (\$ 750.00) per calendar day**
- 4.2.2** as liquidated damages and not as a penalty, until the date of Substantial Completion. Force majeure shall apply relative to both rain/snow delays (acts of nature) and/or supply delays over which Contractor has no control, and such force majeure delays shall not be subject to such reduction of the Contract Price.
- 4.2.3** Owner may deduct liquidated damages described herein from any unpaid amounts then or thereafter due Contractor under this Agreement. Any liquidated damages not so deducted from any unpaid amounts due Contractor shall be payable by Contractor to Owner at the demand of Owner, together with the interest from the date of the demand at a rate equal to the prime interest rate as published by the Wall Street Journal on the **first (1st) business day** after such amounts are demanded.
- 4.2.4** Notwithstanding anything to the contrary in this Agreement, if Owner is unable to recover any portion of liquidated damages in accordance with the terms and conditions herein because it is found to be unenforceable or invalid as a penalty or otherwise, then, Owner shall be entitled to recover from Contractor all of Owner's actual damages in connection with the failure by Contractor to achieve Substantial Completion of the Work within the Contract Time, including, without limitation, direct, indirect, or consequential damages.

ARTICLE 5 PAYMENT:

5.1 Schedule Of Values

Contractor shall submit to the Owner, before the first Application for Payment, a schedule of values allocating the entire Contract Price to the various portions of the Work and prepared in such form and supported by such data to substantiate its accuracy as the Owner may require. This schedule, unless objected to by the Owner, shall be used as a basis for reviewing the Contractor's Applications for Payment.

5.2 Applications For Payment

- 5.2.1** Contractor shall submit to the Owner an itemized Application for Payment prepared in

accordance with the schedule of values for completed portions of the Work. Such application shall be notarized, if required, and supported by such data substantiating the Contractor's right to payment as the Owner may require, such as copies of requisitions from subcontractors and material suppliers and shall reflect retainage if provided for in the Agreement.

5.2.1.1 Such applications may include requests for payment on account of changes in the Work that have been properly authorized by written Change Orders.

5.2.1.2 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a subcontractor or material supplier unless such Work has been performed by others whom the Contractor intends to pay.

5.2.1.3 If requested by Owner or required elsewhere in the Agreement, each Application for Payment shall be accompanied by the following, all in a form and substance satisfactory to the Owner:

- a. With each Application for Payment: a current Sworn Statement from the Contractor setting forth all subcontractors and all material suppliers with whom the Contractor has subcontracted, the amount of each such subcontract, the amount requested for any subcontractor or material supplier in the Application for Payment, and the amount to be paid to the Contractor from such progress payment;
- b. With each Application for Payment: a duly executed Conditional Waiver and Release on Progress Payment from the Contractor and subcontractors establishing receipt of payment or satisfaction of the payment requested by the Contractor in the current Application for Payment;
- c. Commencing with the second Application for Payment submitted by the Contractor, a duly executed Unconditional Waiver and Release on Progress Payment from Contractor and all subcontractors, material suppliers and, where appropriate, lower tier subcontractors that have billed more than five thousand dollars (\$5,000) on a single application of payment, establishing receipt of payment or satisfaction of payment of all amounts requested on behalf of such entities and disbursed prior to submittal by the Contractor of the current Application for Payment;
- d. With the Final Application for Payment: Contractor shall submit a Conditional Waiver and Release on Final Payment as required by Texas Property Code, §53.284. Upon receipt of final payment, Contractor shall submit an Unconditional Waiver and Release on Final Payment as required by Texas Property Code, §53.284; and
- e. Such other information, documentation, and materials as the Owner, or the title insurer (if any) may require in order to ensure that Owner's property is free of lien claims. Such other documents may include, without limitation, original copies of lien or bond claim releases suitable for filing with the County Clerk in Williamson County, Texas.

5.2.2 Unless otherwise provided in the Agreement, payments shall be made on account of

materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage and transportation to the site for such materials and equipment stored off the site.

5.2.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information and belief, be free and clear of liens, bond claims, claims, security interests or encumbrances in favor of the Contractor, subcontractors, material suppliers, or other persons or entities making a claim by reason of having provided labor, materials and equipment relating to the Work.

5.2.3.1 The Contractor further expressly undertakes to defend Owner, at the Contractor's sole expense, against any actions, lawsuits, or proceedings brought against Owner as a result of liens filed against the Work, the site of any of the Work, the Project site and any improvements thereon, or any portion of the property of any of Owner (referred to collectively as "liens" in this paragraph), provided the Owner has paid Contractor pursuant to the requirements of the Agreement. The Contractor hereby agrees to indemnify and hold Owner harmless against any such liens or claims of lien and agrees to pay any judgment or lien resulting from any such actions, lawsuits, or proceedings.

5.2.3.2 The Owner shall release any payments withheld due to a lien or bond claims if the Contractor obtains security acceptable to the Owner, however, the Contractor shall not be relieved of any responsibilities or obligations under this paragraph, including, without limitation, the duty to defend and indemnify Owner.

5.2.3.3 Retainage. The Owner shall withhold from each progress payment, as retainage, five percent (5%) of the total earned amount. Retainage so withheld shall be managed in conformance with Texas Government Code, Chapter 2252, Subchapter B. Any request for reduction or release of retainage shall be accompanied by written consent of the Contractor's Surety. No such request shall be made until the Contractor has earned at least sixty-five percent (65%) of the total Contract Price.

5.2.3.4 For purposes of Texas Government Code, §2251.021 (a)(2), the date the performance of service is completed is the date when the Owner's representative approves the Application for Payment.

5.3 Certificates For Payment

5.3.1 The Owner will, within seven (7) business days after receipt of the Contractor's Application for Payment, issue a Certificate for Payment, with a copy to the Contractor, for such amount as the Owner determines is properly due, or notify the Contractor in writing of the Owner's

reasons for withholding certification in whole or in part as provided.

- 5.3.2** The issuance of a Certificate for Payment will constitute a representation by the Owner, based on the Owner's evaluation of the Work and the data comprising the Application for Payment, that, to the best of the Owner's knowledge, information and belief, the Work has progressed to the point indicated and that the quality of the Work is in accordance with the Agreement. The foregoing representations are subject to an evaluation of the Work for conformance with the Agreement upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Agreement prior to completion and to specific qualifications expressed by the Owner. The issuance of a Certificate for Payment will further constitute a representation that the Contractor is entitled to payment in the amount certified. However, the issuance of a Certificate for Payment will not be a representation that the Owner has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work, (2) reviewed construction means, methods, techniques, sequences or procedures, (3) reviewed copies of requisitions received from subcontractors and material suppliers and other data requested by the Owner to substantiate the Contractor's right to payment, or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Price.

5.4 Decisions To Withhold Certification

- 5.4.1** The Owner may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Owner's opinion the representations to the Owner required herein cannot be made. If the Owner is unable to certify payment in the amount of the Application, the Owner will notify the Contractor. If the Contractor or Contractor and Owner, as the case may be, cannot agree on a revised amount, the Owner will promptly issue a Certificate for Payment for the amount that can be certified. The Owner may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Owner's opinion to protect the Owner from loss for which the Contractor is responsible because of:

5.4.1.1 defective Work not remedied;

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

5.4.1.3 failure of the Contractor to make payments properly to subcontractors or for labor, materials or equipment;

5.4.1.4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Price;

5.4.1.5 damage to the Owner or a separate contractor;

5.4.1.6 failure to maintain the scheduled progress, or reasonable evidence that the Work will not be completed within the Contract Time;

5.4.1.7 failure to comply with the requirements of Texas Government Code, Chapter 2258 (Prevailing Wage Law);

5.4.1.8 failure to include sufficient documentation to support the amount of payment

requested for the Project;

5.4.1.9 failure to obtain, maintain, or renew insurance coverage, payment/performance bonds or warranty bond required by the Agreement; or

5.4.1.10 repeated failure to carry out the Work in accordance with the Agreement.

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

5.5 Progress Payments

5.5.1 The Owner shall make payment in the manner and within the time provided in the Agreement and in accordance with Texas Government Code, Chapter 2251.

5.5.2 The Contractor shall pay each subcontractor and material and equipment suppliers no later than ten (10) calendar days after receipt of payment from the Owner the amount to which the subcontractor or material and equipment suppliers is entitled. Payments to subcontractors may reflect the percentages actually retained from payments to the Contractor on account of the subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each subcontractor, require each subcontractor to make payments to Sub-subcontractors in a similar manner.

5.5.3 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid subcontractors and material and equipment suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven (7) calendar days, the Owner shall have the right to contact subcontractors to ascertain whether they have been properly paid. The Owner shall not have an obligation to pay or to see to the payment of money to a subcontractor, except as may otherwise be required by law.

5.5.4 A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Agreement.

5.6 Failure Of Payment

5.6.1 If the Owner is required to issue Certificates for Payment and, through no fault of the Contractor, the Owner fails to timely issue Certificates for Payment in the time permitted in the Agreement, or if the Owner does not pay the Contractor by the date established in the Agreement, then the Contractor may, upon twenty-one (21) business days written notice to the Owner, stop the Work until payment of the amount owing has been received.

5.6.2 If the Owner is entitled to reimbursement or payment from the Contractor under or pursuant to the Agreement, such payment shall be made promptly upon demand by the Owner. Notwithstanding anything contained in the Agreement to the contrary, if the Contractor fails to promptly make any payment due the Owner, or if the Owner incurs any costs and expenses to cure any default of the Contractor or to correct defective work, the Owner shall have an

absolute right to offset such amount against the Contract Price and may, in the Owner's sole discretion, elect either to (1) deduct an amount equal to that which the Owner is entitled from any payment then or thereafter due the Contractor from the Owner, or (2) issue a written notice to the Contractor reducing the Contract Price by an amount equal to that which the Owner is entitled.

5.7 Substantial Completion

- 5.7.1** Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Agreement so that the Owner can occupy or utilize the Work for its intended use; provided, however, that as a condition precedent to Substantial Completion, the Owner has received all certificates of occupancy and any other permits, approvals, licenses, and other documents from any governmental authority having jurisdiction thereof necessary for the beneficial occupancy of the Project.
- 5.7.2** When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Owner a comprehensive list of items to be completed or corrected prior to final payment (punch list). Failure to include an item on the punch list does not alter the responsibility of the Contractor to complete all Work in accordance with the Agreement.
- 5.7.3** Upon receipt of the Contractor's punch list, the Owner will examine the Work to determine whether the Work or designated portion thereof is substantially complete. If the Owner's examination discloses any item, whether or not included on the Contractor's punch list, that is not sufficiently complete in accordance with the Agreement, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Owner. In such case, the Contractor shall then submit a request for another examination by the Owner to determine Substantial Completion.
- 5.7.4** When the Work or designated portion thereof is substantially complete, the Owner will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion, shall establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance, and shall fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Unless otherwise provided, Contractor shall complete all items on the punch list within thirty (30) calendar days of Substantial Completion. Warranties required by the Agreement shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.
- 5.7.5** The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in such Certificate of Substantial Completion. Upon such acceptance and consent of surety, if any, the Owner shall

make payment of retainage.

5.8 Partial Occupancy or Use

- 5.8.1** The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer, the surety, and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Agreement. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Owner as provided herein. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld.
- 5.8.2** Immediately prior to partial occupancy or use, the Owner and Contractor shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.
- 5.8.3** Partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Agreement.

5.9 Final Completion and Final Payment

- 5.9.1** Upon receipt of the Contractor's written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Owner will make such inspection and, when the Owner finds the Work acceptable under the Agreement and the Agreement fully performed, the Owner will issue a final Certificate for Payment for the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. All warranties and guarantees required under or pursuant to the Agreement shall be assembled and delivered by the Contractor to the Owner as part of the final Application for Payment. The final Certificate for Payment will not be issued by the Owner until all warranties and guarantees have been received and accepted by the Owner.
- 5.9.2** Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Owner (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work have been paid or otherwise satisfied, within the period of time required by Texas Government Code, Chapter 2251, (2) a certificate evidencing that insurance required by the Agreement to remain in force after final payment is currently in effect and will not be canceled or allowed to expire until at least thirty (30) business days prior written notice has been given to the Owner, (3) a written statement that the Contractor knows of no substantial reason that the insurance will not be renewable to cover the period required by the Agreement, (4) consent of surety to final payment, (5) a warranty bond in a form acceptable to Owner, and (6) other data establishing

payment or satisfaction of obligations, such as receipts, unconditional full and final releases and waivers of liens, claims, security interests or encumbrances arising out of the Agreement, to the extent and in such form as may be designated by the Owner.

- 5.9.3** Acceptance of final payment by the Contractor, a subcontractor or material supplier shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 6 CONTRACTOR'S GENERAL RESPONSIBILITIES AND COVENANTS:

6.1 Contractor shall render, diligently and competently in accordance with the highest standards used in the profession, all Contractor services which shall be necessary or advisable for the expeditious, economical and satisfactory completion of the Project. Contractor agrees to use its best efforts, skill, judgment, and abilities to perform its obligations and to further the interests of Owner in accordance with Owner's requirements and procedures.

6.2 Contractor's duties as set forth herein shall at no time be in any way diminished by reason of any approval by the Owner nor shall the Contractor be released from any liability by reason of such approval by the Owner, it being understood that the Owner at all times is ultimately relying upon the Contractor's skill and knowledge in performing the services required hereunder.

6.3 Contractor is responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. The safety program shall comply with all applicable requirements of the current federal Occupational Safety and Health Act and all other applicable federal, state and local laws and regulations.

6.4 Contractor shall be responsible for all construction means, methods, techniques, sequences and procedures, and for coordinating all portions of the Work. The Contractor shall keep the Owner informed of the progress and quality of the Work.

6.5 Insurance. Contractor shall carry insurance in the types and amounts indicated below for the duration of the Agreement, which shall include items owned by Owner in the care, custody and control of Contractor prior to and during construction. Contractor must also complete and file the declaration pages from the insurance policies with Owner whenever a previously identified policy period expires during the term of the Agreement, as proof of continuing coverage. Contractor shall update all expired policies prior to submission of any payment requests hereunder. Failure to update policies shall be reason for payment to be withheld until evidence for renewal is provided to the Owner. If the Contractor fails to obtain, maintain or renew any insurance required by this Agreement, the Owner may, among other remedies available hereunder or at law, obtain insurance coverage directly and recover the cost of that insurance from the Contractor or declare this Agreement void if the Contractor does not remedy the breach within ten (10) days after receipt of notice of breach from the Owner. All policies of insurance provided by the Contractor must comply with the requirements set forth herein, the Agreement and the laws of the State of Texas.

- 6.5.1** The Contractor shall provide and maintain, until the Work covered in the Agreement is completed and accepted by the Owner, the minimum insurance coverages in the minimum amounts as described below.

	Type of Coverage	Limits of Liability
.1	Worker's Compensation	Statutory
.2	Employer's Liability	
	Bodily Injury by Accident	\$500,000 Ea. Accident
	Bodily Injury by Disease	\$500,000 Ea. Employee
	Bodily Injury by Disease	\$500,000 Policy Limit
.3	Commercial general liability including completed operations and contractual liability insurance for bodily injury, death, or property damages in the following amounts:	
	COVERAGE	PER OCCURRENCE
	Commercial General Liability (including premises, completed operations and contractual)	\$1,000,000
	Aggregate policy limits:	\$2,000,000
.4	Comprehensive automobile and auto liability insurance (covering owned, hired, leased and non-owned vehicles):	
	COVERAGE	PER PERSON PER OCCURRENCE
	Bodily injury (including death)	\$1,000,000 \$1,000,000
	Property damage	\$1,000,000 \$1,000,000
	Aggregate policy limits	No aggregate limit
.5	Builder's Risk Insurance (all-risks)	
	An all-risk policy, in the amount equal at all times to 100% of the Contract Price. The policy shall include coverage for loss or damage caused by certified acts of terrorism as defined in the Terrorism Risk Insurance Act. The policy shall be issued in the name of the Contractor and shall name its Subcontractors as additional	

insureds. The Owner shall be named as a loss payee on the policy. The builders risk policy shall have endorsements as follow:

- a. This insurance shall be specific as to coverage and not considered as contributing insurance with any permanent insurance maintained on the present premises. If off-site storage is permitted, coverage shall include transit and storage in an amount sufficient to protect property being transported or stored.
 - b. For renovation projects and or portions of work contained within an existing structure, the Owner waives subrogation for damage by fire to existing building structure(s), if the Builder's Risk Policy has been endorsed to include coverage for existing building structure(s) in the amount described in the Special Conditions. However, Contractor shall not be required to obtain such an endorsement unless specifically required by the Special Conditions in the Agreement. The aforementioned waiver of subrogation shall not be effective unless such endorsement is obtained.
- .6. Flood insurance when specified in Supplementary General Conditions or Special Conditions.
- .7 Umbrella coverage in the amount of not less than \$5,000,000.

6.5.2 Workers' Compensation Insurance Coverage:

1. Definitions:
 - (a) Certificate of coverage ("certificate") - A copy of a certificate of insurance, a certificate of authority to self-insure issued by the Texas Workers' Compensation Commission, or a coverage agreement (TWCC-81, TWCC-82, TWCC-83, or TWCC-84), showing statutory workers' compensation insurance coverage for the person's or entity's employees providing services on a project, for the duration of the Project.
 - (b) Duration of the Project - includes the time from the beginning of the work on the Project until the Contractor's/person's work on the Project has been completed and accepted by the Owner.
 - (c) Coverage – Workers' compensation insurance meeting the statutory requirements of the Texas Labor Code, §401.011(44).
 - (d) Persons providing services on the Project ("subcontractor") - includes all persons or entities performing all or part of the services the Contractor has undertaken to perform on the Project, regardless of whether that person contracted directly with the Contractor and regardless of whether that person has employees. This includes, without limitation, independent contractors, subcontractors, leasing companies, motor carriers, owner-operators, employees of any such entity, or employees of any entity which furnishes persons to provide services on the Project. "Services" include, without limitation, providing, hauling, or delivering equipment or materials, or providing labor, transportation, or other service related to a project.

"Services" does not include activities unrelated to the Project, such as food/beverage vendors, office supply deliveries, and delivery of portable toilets.

2. The Contractor shall provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, §401.011(44) for all employees of the Contractor providing services on the Project, for the duration of the Project.
3. The Contractor must provide a certificate of coverage prior to execution of the Agreement/Contract, and in no event later than ten (10) days from Notice of Award. Failure to provide the insurance in a timely fashion may result in loss of Contractor's bid bond.
4. If the coverage period shown on the Contractor's current certificate of coverage ends during the duration of the Project, the Contractor must, prior to the end of the coverage period, file a new certificate of coverage with the Owner showing that coverage has been extended.
5. The Contractor shall obtain from each person providing services on a project, and provide to the Owner:
 - (a.) a certificate of coverage, prior to that person beginning work on the Project, so the Owner will have on file certificates of coverage showing coverage for all persons providing services on the Project; and
 - (b.) no later than seven days after receipt by the Contractor, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the Project.
6. The Contractor shall retain all required certificates of coverage for the duration of the Project and for one year thereafter.
7. The Contractor shall notify the Owner in writing by certified mail or personal delivery, within 10 days after the Contractor knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the Project.
8. The Contractor shall post on each project site a notice, in the text, form and manner prescribed by the Texas Workers' Compensation Commission, informing all persons providing services on the Project that they are required to be covered, and stating how a person may verify coverage and report lack of coverage.
9. The Contractor shall contractually require each person with who it contracts to provide services on a project, to:
 - (a) provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas labor Code, Section 401.011(44) for all of its employees providing services on the Project, for the duration of the Project;
 - (b) provide to the Contractor, prior to that person beginning work on the Project, a certificate of coverage showing that coverage is being provided for all

employees of the person providing services on the Project, for the duration of the Project;

(c) provide the Contractor, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the Project;

(d) obtain from each other person with whom it contracts, and provide to the Contractor:

i. a certificate of coverage, prior to the other person beginning work on the Project; and

ii. a new certificate of coverage showing extension of coverage, prior to the end of the coverage period, if the coverage period shown on the current certificate of coverage ends during the duration of the Project;

(e) retain all required certificate of coverage on file for the duration of the Project and for one year thereafter;

(f) notify the Owner in writing by certified mail or personal delivery, within 10 days after the person knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the Project; and

(g) contractually require each person with whom it contracts, to perform as required by paragraphs (a)-(g), with the certificates of coverage to be provided to the person for whom they are providing services.

10. By signing the Agreement/Contract or providing or causing to be provided a certificate of coverage, the Contractor is representing to the Owner that all employees of the Contractor who will provide services on the Project will be covered by workers' compensation coverage for the duration of the Project, that the coverage will be based on proper reporting of classification codes and payroll amounts, and that all coverage agreements will be filed with the appropriate insurance carrier or, in the case of a self-insured, with the Commission's Division of Self-Insurance Regulation. Providing false or misleading information may subject the Contractor to administrative penalties, criminal penalties, civil penalties, or other civil actions.

11. The Contractor's failure to comply with any of these provisions is a breach of contract by the Contractor which entitles the Owner to declare the Agreement/Contract void if the Contractor does not remedy the breach within ten days after receipt of notice of breach from the Owner.

6.5.3 If insurance policies are not written for the amounts specified herein, Contractor shall carry Umbrella or Excess Liability Insurance for any differences in amounts specified. If Excess Liability Insurance is provided, it shall follow the form of primary coverage.

6.5.4 Insurance coverage required hereunder shall be written on an occurrence basis by companies authorized and admitted to do business in the State of Texas and rated A- or better by A.M. Best Company, or otherwise acceptable to Owner.

- 6.5.5 The Owner (“Williamson County, Texas”), its officials, employees and volunteers shall be named as an additional insured on all required policies.** These insurance policies shall contain the appropriate additional insured endorsement signed by a person authorized by that insurer to bind coverage on its behalf.
- 6.5.6** The furnishing of the above listed insurance coverage, as may be modified by the Agreement, must be tendered prior to execution of the Agreement/Contract, and in no event later than ten (10) days from Notice of Award. Failure to provide the insurance in a timely fashion may result in loss of Contractor’s bid bond.
- 6.5.7** Owner reserves the right to review the insurance requirements set forth herein during the Agreement and to make reasonable adjustments to the insurance coverage and their limits when deemed necessary and prudent by the Owner based upon changes in statutory law, court decisions, or the claims history of the industry as well as the Contractor.
- 6.5.8** Owner shall be entitled, upon request, and without expense, to receive complete copies of the policies with all endorsements and may make any reasonable requests for deletion, or revision or modification of particular policy terms, conditions, limitations, or exclusions, except where policy provisions are established by law or regulation binding upon the Parties or the underwriter of any of such policies. Damages caused by the Contractor and not covered by insurance shall be paid by the Contractor.
- 6.5.9** Contractor shall be responsible for payment of premiums for all of the insurance coverages required hereunder. Contractor further agrees that for each claim, suit or action made against insurance provided hereunder, with respect to all matters for which the Contractor is responsible hereunder, Contractor shall be solely responsible for all deductibles and self-insured retentions. Any deductibles or self-insured retentions over \$75,000 in the Contractor’s insurance must be declared and approved in writing by Owner in advance.
- 6.5.10** Contractor shall contractually require each person or entity with whom it contracts to provide services in relation to the Work, to comply with every insurance requirement that Contractor must comply with hereunder. More specifically, each person or entity with whom Contractor contracts to provide services on the in relation to the Work must comply with each insurance requirement hereunder just as if such person or entity was the Contractor. Thus, every reference to Contractor under each insurance requirement hereunder shall mean and include each person or entity with whom Contractor contracts to provide services in relation to the Work. If any such person or entity with whom Contractor contracts to provide services in relation to the Work fails to obtain, maintain or renew any insurance required by this Agreement, Owner may, among other remedies available hereunder or at law, obtain insurance coverage directly and recover the cost of that insurance from the Contractor or declare this Agreement void if the Contractor does not remedy the breach within ten (10) days after receipt of notice of breach from the Owner.

ARTICLE 7 INDEMNITY:

7.1 INDEMNIFICATION - EMPLOYEE PERSONAL INJURY CLAIMS. TO THE FULLEST EXTENT PERMITTED BY LAW, Contractor SHALL INDEMNIFY, DEFEND (WITH COUNSEL OF OWNER’S CHOOSING), AND HOLD HARMLESS OWNER, AND OWNER’S EMPLOYEES, AGENTS, REPRESENTATIVES, PARTNERS, OFFICERS, AND DIRECTORS (COLLECTIVELY, THE “INDEMNITEES”) AND SHALL ASSUME ENTIRE RESPONSIBILITY AND LIABILITY (OTHER THAN AS A RESULT OF INDEMNITEES’ GROSS NEGLIGENCE) FOR ANY CLAIM OR ACTION BASED ON OR ARISING OUT OF THE PERSONAL INJURY, OR DEATH, OF ANY EMPLOYEE OF CONTRACTOR, OR OF ANY SUBCONTRACTOR, OR OF ANY OTHER ENTITY FOR WHOSE ACTS THEY MAY BE LIABLE, WHICH OCCURRED OR WAS ALLEGED TO HAVE OCCURRED ON THE PROJECT SITE OR IN CONNECTION WITH THE PERFORMANCE OF THE WORK. CONTRACTOR HEREBY INDEMNIFIES THE INDEMNITEES EVEN TO THE EXTENT THAT SUCH PERSONAL INJURY WAS CAUSED OR ALLEGED TO HAVE BEEN CAUSED BY THE SOLE, COMPARATIVE OR CONCURRENT NEGLIGENCE OR THE STRICT LIABILITY OF ANY INDEMNIFIED PARTY. THIS INDEMNIFICATION SHALL NOT BE LIMITED TO DAMAGES, COMPENSATION, OR BENEFITS PAYABLE UNDER INSURANCE POLICIES, WORKERS COMPENSATION ACTS, DISABILITY BENEFITS ACTS, OR OTHER EMPLOYEES BENEFIT ACTS.

INDEMNIFICATION - OTHER THAN EMPLOYEE PERSONAL INJURY CLAIMS. TO THE FULLEST EXTENT PERMITTED BY LAW, CONTRACTOR SHALL INDEMNIFY, DEFEND (WITH COUNSEL OF OWNER’S CHOOSING), AND HOLD HARMLESS OWNER, AND OWNER’S EMPLOYEES, AGENTS, REPRESENTATIVES, PARTNERS, OFFICERS, AND DIRECTORS (COLLECTIVELY, THE “INDEMNITEES”) FROM AND AGAINST CLAIMS, DAMAGES, LOSSES AND EXPENSES, INCLUDING BUT NOT LIMITED TO ATTORNEYS’ FEES, ARISING OUT OF OR ALLEGED TO BE RESULTING FROM THE PERFORMANCE OF THIS AGREEMENT OR THE WORK DESCRIBED HEREIN, TO THE EXTENT CAUSED BY THE NEGLIGENCE, ACTS, ERRORS, OR OMISSIONS OF CONTRACTOR OR ITS SUBCONTRACTORS, ANYONE EMPLOYED BY THEM OR ANYONE FOR WHOSE ACTS THEY MAY BE LIABLE, REGARDLESS OF WHETHER OR NOT SUCH CLAIM, DAMAGE, LOSS OR EXPENSE IS CAUSED IN WHOLE OR IN PART BY A PARTY INDEMNIFIED HEREUNDER.

7.2 Except for the obligation of Owner to pay Contractor the Contract Price pursuant to the terms of this Agreement, and to perform certain other obligations pursuant to the terms and conditions explicitly set forth herein, Owner shall have no liability to Contractor or to anyone claiming through or under Contractor by reason of the execution or performance of this Agreement. Notwithstanding any obligation or liability of Owner to Contractor, no present or future partner or affiliate of Owner or any agent, officer, director, or employee of Owner, or of the various departments comprising Owner, or anyone claiming under Owner has or shall have any personal liability to Contractor or to anyone claiming through or under Contractor by reason of the execution or performance of this Agreement.

ARTICLE 8 WARRANTY:

8.1 Contractor hereby warrants that the materials and equipment provided for the Work will be of good quality and new unless otherwise required or permitted by the Owner; that the construction will be free from faults and defects; and that the construction will conform with the requirements of the plans, specifications, drawings and the terms of this Agreement.

8.2 Contractor shall provide warranty services for the Work for a **full twelve (12) months** following Final Completion and final payment. Just before the warranty period expires, Contractor shall attend an on-site meeting with the Owner to ensure that all warranty issues have been identified and properly remedied.

ARTICLE 9 PREVAILING WAGE RATE:

9.1 Duty to Pay Prevailing Wage Rates. The Contractor shall pay not less than the wage scale of the various classes of labor as shown on the “Prevailing Wage Schedule”, as defined below. The specified wage rates are minimum rates only, and are not representations that qualified labor adequate to perform the Work is available locally at the prevailing wage rates. The Owner is not bound to pay—and will not consider—any claims for additional compensation made by any Contractor because the Contractor pays wages in excess of the applicable minimum rate contained in the Agreement. The “Prevailing Wage Schedule” is not a representation that quantities of qualified labor adequate to perform the Work may be found locally at the specified wage rates.

9.1.2 For classifications not shown, workers shall not be paid less than the wage indicated for Laborers. The Contractor shall notify each worker commencing work on the Project of the worker’s job classification and the established minimum wage rate required to be paid, as well as the actual amount being paid. The notice must be delivered to and signed in acknowledgement of receipt by the employee and must list both the monetary wages and fringe benefits to be paid or furnished for each classification in which the worker is assigned duties. When requested by Owner, competent evidence of compliance with the Texas Prevailing Wage Law shall be furnished by Contractor.

9.1.3 A copy of each worker wage rate notification shall be submitted to the Owner with the Application for Payment for the period during which the worker began on-site activities.

9.2 Prevailing Wage Schedule. Pursuant to Texas Government Code Section 2258.022(2), the general prevailing rate of per diem wages for each craft or type of worker needed to execute the Contract and the prevailing rate for legal holiday and overtime work shall be the most recent prevailing wage rate for Williamson County, Texas for building construction as determined by the United States Department of Labor in accordance with the Davis-Bacon Act (40 U.S.C. Section 276a et seq.), and its subsequent amendments, which are published and can be obtained online at <https://sam.gov/search/?index=dbra> (the “Prevailing Wage Schedule”). Should the Contractor at any time become aware that a particular skill or trade not reflected on the Prevailing Wage Schedule will be or is being employed in the Work, whether by the Contractor or by a subcontractor, the Contractor shall promptly inform the Owner and shall specify a wage rate for that skill or trade, which shall bind the Contractor.

9.3 Penalty for Violation. The Contractor and any Subcontractor shall pay to the Owner a penalty of sixty dollars (\$60.00) for each worker employed for each calendar day, or portion thereof, that the worker is paid less than the wage rates stipulated in the Prevailing Wage Schedule or any supplement or update thereto pursuant to provisions above. The Contractor and each Subcontractor shall keep, or cause to be kept, an accurate record showing the names and occupations of all workers employed in connection with the Work, and showing the actual per

diem wages paid to each worker, which records shall be open at all reasonable hours for the inspection by the Owner.

9.4 Complaints of Violations of Prevailing Wage Rates. Within thirty-one (31) days of receipt of information concerning a violation of Texas Government Code, Chapter 2258, the Owner shall make an initial determination as to whether good cause exists to believe a violation occurred. The Owner's decision on the initial determination shall be reduced to writing and sent to the Contractor or Subcontractor against whom the violation was alleged, and to the affected worker. When a good cause finding is made, the Owner shall retain the full amounts claimed by the claimant or claimants as the difference between wages paid and wages due under the Prevailing Wage Schedule and any supplements thereto, together with the applicable penalties, such amounts being subtracted from successive progress payments pending a final decision on the violation.

9.5 Arbitration Required if Violation not Resolved. After the Owner makes its initial determination, the affected Contractor or Subcontractor and worker have fourteen (14) days in which to resolve the issue of whether a violation occurred, including the amount that should be retained by Owner or paid to the affected worker. If the Contractor or Subcontractor and affected worker reach an agreement concerning the worker's claim, the Contractor shall promptly notify the Owner in a written document signed by the worker. If the Contractor or Subcontractor and affected worker do not agree before the fifteenth (15th) day after the Owner's determination, the Contractor or Subcontractor and affected worker must participate in binding arbitration in accordance with the Texas General Arbitration Act, Chapter 171, Tex. Civ. Prac. & Rem. Code. The parties to the arbitration have ten (10) days after the expiration of the fifteen (15) days referred to above, to agree on an arbitrator; if by the eleventh (11th) day there is no agreement to an arbitrator, a district court shall appoint an arbitrator on the petition of any of the parties to the arbitration.

9.6 Arbitration Award. If an arbitrator determines that a violation has occurred, the arbitrator shall assess and award against the Contractor or Subcontractor the amount of penalty as provided herein and the amount owed the worker. The Owner may use any amounts retained hereunder to pay the worker the amount as designated in the arbitration award. If the Owner has not retained enough from the Contractor or Subcontractor to pay the worker in accordance with the arbitration award, the worker has a right of action against the Contractor and Subcontractor as appropriate, and the surety of either to receive the amount owed, attorneys' fees and court costs. The Contractor shall promptly furnish a copy of the arbitration award to the Owner.

9.7 Prevailing Wage Retainage. Money retained pursuant to this section shall be used to pay the claimant or claimants the difference between the amount the worker received in wages for labor on the Project at the rate paid by the Contractor or Subcontractor and the amount the worker would have received at the general prevailing wage rate as provided by the agreement of the claimant and the Contractor or Subcontractor affected, or in the arbitrator's award. The full statutory penalty of sixty dollars (\$60.00) per day of violation per worker shall be retained by the Owner to offset its administrative costs, pursuant to Texas Government Code, §2258.023. Any retained funds in excess of these amounts shall be paid to the Contractor on the earlier of the next progress payment or final payment. Provided, however, that the Owner shall have no duty to

release any funds to either the claimant or the Contractor until it has received the notices of agreement or the arbitration award as provided in this section.

9.8 No Extension of Time. If the Owner determines that good cause exists to believe a violation has occurred, the Contractor shall not be entitled to an extension of time for any delay arising directly or indirectly from of the procedures set forth in this section.

ARTICLE 10 BONDS:

10.1 Performance Bond. Upon execution of this Agreement, Contractor shall provide a Performance Bond in the amount of 100% of the Contract Price. The surety for a Performance Bond shall meet the requirements of Texas law and the requirements set forth in the Agreement.

10.2 Payment Bond. Upon execution of this Agreement, Contractor shall provide a Payment Bond in the amount of 100% of the Contract Price, as security for the true and faithful payment in full of all subcontractors and persons performing labor, services, materials, machinery, and fixtures in connection with the Work. The surety for a Payment Bond shall meet the requirements of Texas law and the requirements set forth in the Agreement.

10.3 Warranty Bond. Upon Final Completion, Contractor shall provide a Warranty Bond in the amount of 20% of the Contract Price, as security for the true and faithful performance of all warranties set forth in the Agreement.

ARTICLE 11 TERMINATION OR SUSPENSION OF THE AGREEMENT

11.1 Termination by Contractor

If one of the reasons described below exists, the Contractor may, upon thirty (30) business days written notice to the Owner, terminate the Agreement and recover from the Owner payment for Work executed, including reasonable overhead, profit, and costs incurred by reason of such termination:

- 11.1.1** Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;
- 11.1.2** An act of government, such as a declaration of national emergency that requires all Work to be stopped;
- 11.1.3** Because the Owner has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in the Agreement, or because the Owner has not made payment on an undisputed Certificate for Payment within the time stated in the Agreement; or
- 11.1.4** If the Work is stopped for a period of ninety (90) consecutive days through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons or entities performing portions of the Work under direct or indirect contract with the Agreement.

11.2 Termination by the Owner for Cause

11.2.1 The Owner may terminate the Agreement if the Contractor:

- 11.2.1.1** Fails to commence the Work in accordance with the provisions of the Agreement;
- 11.2.1.2** Fails to prosecute the Work to completion thereof in a diligent, efficient, timely, workmanlike, skillful and careful manner and in strict accordance with the provisions of the Agreement;
- 11.2.1.3** Fails to use an adequate amount or quality of personnel or equipment to complete the Work without undue delay;
- 11.2.1.4** Fails to perform any of its obligations under the Agreement;
- 11.2.1.5** Fails to make prompt payments when due to its Subcontractors and Suppliers, or as required by **Texas Government Code, Chapter 2251**;
- 11.2.1.6** Files any petition or other pleading seeking any relief under any provisions of the Federal Bankruptcy Act, as amended, or any other federal or state statute or law providing for reorganization of debts or other relief from creditors, permits a receiver or other person to be appointed on account of its insolvency or financial condition, or becomes insolvent;
- 11.2.1.7** Creates any situation or state of facts which would authorize or permit an involuntary petition in bankruptcy to be filed against Contractor; or
- 11.2.1.8** Has not met or in Owner's opinion will not meet the dates of Substantial Completion set forth in the Agreement.

11.2.2 When any of the reasons under **Paragraph 11.2.1** exist, the Owner, in its sole and absolute discretion, may without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, **thirty (30) calendar days** written notice, terminate employment of the Contractor and may, subject to any prior rights of the surety, exclude the Contractor from the Project site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor; accept assignment of subcontracts of Contractors subcontractors; and finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

11.2.3 When the Owner terminates the Agreement for one of the reasons stated in **Paragraph 11.2.1**, the Contractor shall not be entitled to receive further payment until the Work is finished. In the event that it is determined that sufficient cause did not exist for termination under this **Section 11.2**, then the termination shall be considered a termination for convenience, under **Section 11.4**, below.

11.2.4 If the unpaid balance of the Contract Price exceeds costs of finishing the Work, including compensation for expenses made necessary thereby, and other damages and costs incurred by the Owner in finishing the Work and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner.

11.3 Suspension by the Owner for Convenience

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

11.3.2 The Contract Price and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay or interruption as described in **Paragraph 11.3.1**. Adjustment of the Contract Price shall include profit. No adjustment shall be made to the extent:

11.3.2.1 that performance is, was or would have been so suspended, delayed or interrupted by another cause for which the Contractor is responsible; or

11.3.2.2 that an equitable adjustment is made or denied under another provision of the Agreement.

11.4 Termination by the Owner for Convenience

11.4.1 The Owner may, at any time, terminate the Agreement for the Owner's convenience and without cause.

11.4.2 Upon receipt of written notice from the Owner of such termination for the Owner's convenience, the Contractor shall

11.4.2.1 Cease operations as directed by the Owner in the notice;

11.4.2.2 Take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and

11.4.2.3 Except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

11.4.3 Upon Owner's termination for convenience, costs of the Work executed, including reasonable overhead and profit, incurred to and including the date of termination, will be due and payable to Contractor in accordance with the Agreement.

ARTICLE 12 MISCELLANEOUS PROVISIONS

12.1 Interest and Late Payments. Owner's payment for goods and services shall be governed by Chapter 2251 of the Texas Government Code. Interest charges for any overdue payments shall be paid by Owner in accordance with Texas Government Code Section 2251.025. More specifically, the rate of interest that shall accrue on a late payment is the rate in effect on September 1 of Owner's fiscal year in which the payment becomes due. The said rate in effect on September 1 shall be equal to the sum of one percent (1%); and (2) the prime rate published in the Wall Street Journal on the first day of July of the preceding fiscal year that does not fall on a Saturday or Sunday.

In the event that an error appears in an invoice/application for payment submitted by Contractor, Owner shall notify Contractor of the error not later than the twenty first (21st) day after the date Owner receives the invoice/application for payment. If the error is resolved in favor of Contractor, Contractor shall be entitled to receive interest on the unpaid balance of the invoice/application for

payment submitted by Contractor beginning on the date that the payment for the invoice/application for payment became overdue. If the error is resolved in favor of the Owner, Contractor shall submit a corrected invoice/application for payment that must be paid in accordance within the time set forth above. The unpaid balance accrues interest as provided by Chapter 2251 of the Texas Government Code if the corrected invoice/application for payment is not paid by the appropriate date.

12.2 Audits. Contractor agrees that Owner or its duly authorized representatives shall, until the expiration of three (3) years after final payment under this Agreement, have access to and the right to examine and photocopy any and all books, documents, papers and records of Contractor which are directly pertinent to the services to be performed under this Agreement for the purposes of making audits, examinations, excerpts, and transcriptions. Contractor agrees that Owner shall have access during normal working hours to all necessary Contractor facilities and shall be provided adequate and appropriate work space in order to conduct audits in compliance with the provisions of this section. Owner shall give Contractor reasonable advance notice of intended audits.

12.3 Assignment. This Agreement is a personal service contract for the services of Contractor, and Contractor's interest in this Agreement, duties hereunder and/or fees due hereunder may not be assigned or delegated to a third party.

12.4 Governing Law and Venue. This Agreement and all of the rights and obligations of the parties and all of the terms and conditions shall be construed, interpreted and applied in accordance with and governed by and enforced under the laws of the State of Texas without reference to its conflicts of law provisions. Williamson County, Texas where the Project is located shall be the sole place of venue for any legal action arising from or related to this Agreement or the Project in which the Owner is a party.

12.5 Binding Effect. This Agreement shall be binding upon and inure to the benefit of the parties and their respective permitted assigns and successors.

12.6 Notices. All notices, consents, approvals, demands, requests or other communications relied on by the parties shall be in writing. Written notice shall be deemed to have been given when delivered in person to the designated representative of the Contractor or Owner for whom it is intended; or sent by U. S. Mail to the last known business address of the designated representative.

12.7 Severability. Should any term or provision of this Agreement be held invalid or unenforceable in any respect, the remaining terms and provisions shall not be affected and this Agreement shall be construed as if the invalid or unenforceable term or provision had never been included.

12.8 Relationship of the Parties. GC shall be an independent contractor under this Contract and shall assume all of the rights, obligations, liabilities, applicable to it as such independent contractor hereunder and any provisions in this Contract which may appear to give County the right to direct GC as to details of doing the Work herein covered or to exercise a measure of control over the Work shall be deemed to mean that GC shall follow the desires of County in the results

of the Work only. County shall not retain or have the right to control the GC's means, methods or details pertaining to the GC's performance of the Work described herein, nor shall County have the power to direct the order in which GC's Work is performed under this Contract. County and GC hereby agree and declare that GC is an independent contractor and, as such, meets the qualifications of an Independent Contractor under Texas Worker's Compensation Act, Texas Labor Code, Section 406.141, that the GC is not an employee of County for purposes of this Contract, and that the GC and its employees, agents and sub-subcontractors shall not be entitled to worker's compensation coverage or any other type of insurance coverage held by County.

12.9 Force Majeure. If the party obligated to perform is prevented from performance by an act of war, order of legal authority, act of God, or other unavoidable cause not attributable to the fault or negligence of said party, the other party shall grant such party relief from the performance of this Agreement. The burden of proof for the need of such relief shall rest upon the party obligated to perform. To obtain release based on force majeure, the party obligated to perform shall file a written request with the other party.

12.10 No Waiver of Sovereign Immunity. Nothing herein shall be construed as a waiver of sovereign immunity by Owner.

12.11 Current Revenues. Under Texas law, a contract with a governmental entity that contains a claim against future revenues is void; therefore, each party paying for the performance of governmental functions or services must make those payments from current revenues available to the paying party.

12.12 Compliance with Laws. Contractor shall comply with all federal, state, and local laws, statutes, ordinances, rules and regulations, and the orders and decrees of any courts or administrative bodies or tribunals in any matter affecting the performance of this Agreement, including, without limitation, Worker's Compensation laws, minimum and maximum salary and wage statutes and regulations, licensing laws and regulations. When required, Contractor shall furnish the Owner with certification of compliance with said laws, statutes, ordinances, rules, regulations, orders, and decrees above specified.

12.13 Entire Agreement & Incorporated Documents; Conflicting Terms. This Agreement constitutes the entire agreement between the parties and may not be modified or amended other than by a written instrument executed by both parties.

The following documents shall comprise the Contract Documents:

1. This Agreement between Owner and Contractor;
2. Exhibit "A" – Plans and Specifications;
3. Addenda issued prior to the Effective Date of this Agreement;
4. The Request for Proposal/Invitation for Bids documents defined in Williamson County RFCSP #25RFCSP69;
5. Contractor's Proposal/Bid submitted in response to Williamson County
6. RFCSP #25RFCSP69; and

7. All Change Orders and any other Modifications issued after the Effective Date of this Agreement.

In the event of a dispute or conflict relating to the terms and conditions of the Contract Documents, applicable documents will be referred to for the purpose of clarification, conflict resolution or for additional detail in the following order of precedence:

1. This Agreement between Owner and Contractor;
2. Exhibit "A" – Plans and Specifications;
3. Addenda issued prior to the Effective Date of this Agreement;
4. The Request for Proposal/Invitation for Bids documents defined in Williamson County RFCSP #25RFCSP69;
5. Contractor's Proposal/Bid submitted in response to Williamson County RFCSP #25RFCSP69; and
6. All Change Orders and any other Modifications issued after the Effective Date of this Agreement.

BY SIGNING BELOW, the Parties have executed and bound themselves to this Agreement to be effective as of the date of the last party's execution hereof.

OWNER:

WILLIAMSON COUNTY, TEXAS,
a political subdivision of the state of Texas

By: _____

Printed Name: _____

Title: _____

Date: _____

CONTRACTOR:

The Brandt Companies, LLC

By:  _____

Printed Name: Jordan Green

Title: Director

Date: 11/20/2025

Exhibit “A”

Plans and Specifications

Location: 911 Tracy Chambers Lane, Georgetown, TX 78626

Scope of Work:

Owners Project is to add redundancy to HVAC system or the Data Center located at the ESOC to include additional CRAC Units. The Project includes all utilities, drainage, roadways, parking, landscaping and walkways to structures, and landscaping associated with structures.

WILLIAMSON COUNTY ESOC DATA CENTER COOLING UPGRADES

Issue for Construction:
July 20, 2023

Prepared for:
Williamson County

Prepared by

Ramirez - Simon
 **ngineering, LLC**

9805 Whithorn Houston Texas 77095

Firm Registration No. F-14781



07/20/2023



07/20/2023



07/20/2023

**WILLIAMSON COUNTY ESOC DATA
CENTER COOLING UPGRADES**

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MEP ENGINEER: **RAMIREZ SIMON ENGINEERING, LLC**
9805 Whithorn Drive
Houston, TX 77095
TBPE Firm No. F-14781

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Section 5.4	Connection Methods for Internal Grounding (Earthing) System

SECTION 03 20 00

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Includes furnishing all materials, equipment, transportation and facilities and performing all labor necessary for the following:
 - 1. Prepare shop drawings of reinforcing steel.
 - 2. Furnish and place reinforcing steel.
 - 3. Fabrication and installation of embedded metal assemblies.
- B. Related Documents: The Contract Documents, as defined in Division 01 Section - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.
- C. Related Sections include the following:
 - 1. Division 01 Section - Quality Requirements.
 - 2. Division 03 Section - Concrete Formwork.
 - 3. Division 03 Section - Cast-in-Place Concrete.
 - 4. Division 03 Section - Tilt-Up Concrete.
 - 5. Division 31 Section - "Drilled Piers.

1.03 SUBMITTALS

- A. Division 01 Section - Submittal Procedures: Procedures for submittals.
- B. Shop Drawings: Submit shop and installation drawings of reinforcement and embedded metal assemblies for review by the Engineer. Reproduce the bar bending diagram, the beam, slab and joist notes and cast-in-place concrete notes that concern the proper placing of reinforcing and submit it with each set of shop drawings for field use. Use same bar marks on bar bending diagrams as used on the beam, and slab schedule. Use same beam, and wall marks as Contract Documents.
- C. Mill Test Reports: Deliver certified copies, evidencing compliance with all requirements of these specifications to the Engineer with all deliveries of reinforcing steel.
- D. Submit copies of laboratory inspection reports as follows:
 - 1. Steel Supplier - 1 Copy
 - 2. General Contractor - 1 Copy
 - 3. Owner - 1 Copy
 - 4. Architect - 1 Copy
 - 5. Structural Engineer - 1 Copy

1.04 LABORATORY TESTING AND INSPECTION

- A. Inspect welding of deformed bar anchors at the beginning of each period of production for size, length and quality. Re-inspect corrected welds.
- B. Reinforcing: inspect all reinforcing steel prior to placement of concrete for compliance with the Contract Documents and the approved shop drawings. All instances of noncompliance shall be immediately brought to the attention of the Contractor. If uncorrected by the contractor, they shall be listed in the report.
 - 1. Observe and report the following: number and size of bars; bending; splicing; clearance to forms; clearance between bars; rust, form oil or other contamination; fabrication and installation of embedded metal assemblies, including visual inspection of all welds.
- C. Inspector shall have a minimum of three years of experience inspecting reinforcing steel in projects of similar size.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Reinforcing: All of domestic manufacturers.
 - 1. Bars: New deformed billet steel, ASTM A-615, grade 60.
 - 2. Reinforcing bars to be welded: ASTM A706; Bars shall have a carbon content not exceeding 0.30% and a manganese content not exceeding 0.60%. Provide certified copies of the ladle analysis for each lot of bars to be welded.
 - 3. Welded Wire Fabric: "Specification for Steel Welded Wire Fabric" (ASTM A185) with yield strength $F_y=60,000$ psi.
 - 4. Epoxy coated reinforcing bars: Not used
- B. Fiber reinforcing: Not Used
- C. Concrete accessories including bar supports, chairs, spacers, etc.: Cold-drawn wire and fabricated in accordance with the requirements of Chapter Seven of the ACI Standard 315 with heights as required.
- D. Bar supports for concrete resting on earth: Precast concrete briquettes having tie wires embedded therein, or individual high chairs No. HCP with welded plates on bottom as manufactured by Hohmann & Barnard, Inc. Provide bar supports, hot-dipped galvanized after fabrication, where concrete will be exposed including ceilings of flat slabs.
- E. Bar supports for reinforcing placed over carton forms to be of type to prevent puncturing the carton form.

2.02 METAL ANCHORAGE & CONFINEMENT ASSEMBLIES

- A. Steel bars, plates, angles and miscellaneous steel: ASTM A36
- B. Welded Deformed Bar Anchors: Welded by full-fusion process; "Nelson" Anchors Type D2L or approved equal conforming to ASTM A496 and AWS D1.1
- C. Headed Stud Anchors: Headed Studs welded by full fusion process as furnished by Nelson Stud Welding Company or approved equal, conforming to AWS D1.1 Section 7, Type A.
- D. Bolts: Conform to ASTM F1554 with regular hexagon nuts and carbon steel washers.
- E. Straps: Conform to ASTM A245 or A284.
- F. Welding Electrodes: ASTM Designation A233, Series E70 - AWS 5.5.

2.03 FABRICATION

- A. Fabricate reinforcing steel in compliance with the CRSI "Manual of Standard Practice".
- B. All bar splices shall be a minimum of Class "A" lap unless specified otherwise on drawings.
- C. Shop-fabricate reinforcing bars to conform to the required shapes and dimensions, with fabrication tolerances complying with ACI 315. In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken the material.
- D. Deliver all reinforcement to the project site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.
- E. Reinforcing with any of the following defects will not be permitted in the work: Bar lengths, depths, and bends exceeding the specified fabrication tolerances, bends or kinks not indicated on drawings or final shop drawings, bars with reduced cross-section due to excessive rusting or other cause.

2.04 COATING

- A. Rust inhibitor for field application to metal accessories shall be Hi-Build Epoxoline manufactured by the TNEMEC Co., Kansas City, Missouri or approved equal.
- B. Hot dip galvanizing shall conform to ASTM A123.
- C. Cold Galvanizing Compound for field repair of galvanizing shall be "ZRC Cold Galvanizing Compound" by ZRC Chemical Products Company, Quincy, Massachusetts, or approved equal.

PART 3 - EXECUTION

3.01 MATERIAL STORAGE

- A. Stack reinforcing steel in tiers. Exercise care to maintain all reinforcement free of dirt, mud, paint, rust, etc.

3.02 GENERAL

- A. Place reinforcing steel of the sizes, shapes, lengths, spacing and other dimensions where shown on the drawings. Details of reinforcing shall conform to the ACI Building Code Requirements for Structural Concrete (ACI 318-14).

3.03 MARKING

- A. Mark bars plainly. Limit bundles to 1 size and 1 length and tag each bundle with metal tags.

3.04 CLEANING

- A. Clean reinforcement thoroughly of rust, mill scale, dirt, oil or other coatings which might tend to reduce the bonding to the concrete.

3.05 BENDING

- A. Bend bars cold. Heating of reinforcement, or handling by makeshift methods, will not be permitted and bars having kinks or bends not required will be rejected.

3.06 PLACING

- A. Comply with the specified codes and standards, and the Concrete Reinforcing Steel Institute recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.
- B. Place reinforcement accurately, securely saddle tie at every other intersection with No. 18 gauge black annealed wire, and rigidly hold in place during the placing of the concrete by means of metal chairs or spacers.
- C. Hold bars in position and to proper clearance of concrete surface by spacers, chairs, or other necessary supports with the following tolerances:
 - 1. Top bars in slabs and beams:
 - a. Members 8" deep or less: $\pm 3/8"$
 - b. Members more than 8" but not over 2' deep: $\pm 1/2"$
 - c. Members more than 2': $\pm 3/4"$
 - 2. Lengthwise of members: $\pm 2"$
 - 3. Concrete cover to formed surfaces: $\pm 1/4"$
 - 4. Minimum spacing between bars: $\pm 1/4"$

3.07 CONCRETE PROTECTION

- A. Minimum protection for reinforcing steel shall be as follows:
 - 1. Concrete cast against and permanently exposed to earth: 3"
 - 2. Concrete exposed to earth or weather or cast in place against a vapor retarder
 - a. #6 thru #18 bars: 2"
 - b. #5 bars and smaller: 1 1/2"
 - 3. Concrete not exposed to weather or in contact with the ground:
 - a. Slabs, walls, joists with #14 & #18 bars: 1 1/2"
 - b. Slabs, walls, joists with #11 bars and smaller: 3/4"
 - c. Beam and column primary reinforcement, ties, stirrups, and spirals: 1 1/2"

3.08 EMBEDDED METAL ASSEMBLIES

- A. Fabricate and assemble structural steel items in the shop. Shearing, flame cutting, and chipping shall be done carefully and accurately. Holes shall be cut, drilled, or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Welded construction shall conform to the AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings and AWS D1.1. Welding shall be done by AWS certified welders.
- B. Welding of deformed bar anchors and headed stud anchors shall be done by full-fusion process equal to that of Nelson Stud Welding Company.

END OF SECTION 03 2000

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
1. Cast-in-place (CIP) concrete in building frame elements, walls, foundations, foundation walls, slabs-on-ground, and mechanical equipment pads.
 2. Finishing of concrete floor slabs and toppings. Concrete liquid surface treatment, sealer, and slip-resistant coatings.
 3. Mix Designs
 4. Expansion and contraction, control joints in CIP concrete.
 5. Concrete curing and protection.
 6. Non-shrink grout including installation and forming.
- B. Related Sections:
1. Division 03 Section - Concrete Forms and Accessories.
 2. Division 03 Section - Concrete Reinforcement.
 3. Division 03 Section - Polished Concrete Floor Finishing, for additional requirements for slabs to receive polished finish.

1.03 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO)
1. AASHTO M182
- B. American Concrete Institute (ACI):
1. ACI 121R, "Quality Assurance Systems for Concrete Construction."
 2. ACI 301, "Specification for Structure /Concrete."
 3. ACI 302.1R, "Guide for Concrete Floor and Slab Construction."
 4. ACI 304.2-R, "Placing Concrete by Pumping Methods."
 5. ACI 305, "Hot Weather Concreting."
 6. ACI 306, "Cold Weather Concreting."
 7. ACI 315, "Manual of Standard Practice for Detailing Concrete Structures."
 8. ACI 347, "Recommended Practice for Concrete Formwork."
 9. ACI 503.2, "Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive."
 10. ACI SP-15, "Field Reference Manual" which includes ACI 301 "Specifications for Structural Concrete for Buildings" and reference standards specified therein.
 11. ACI 318-08, "Building Code Requirements for Structural Concrete."
- C. American Welding Society (AWS)
1. AWS D1.4, "Structural Welding Code Reinforcing."
- D. American Society for Testing and Materials (ASTM).

1. ASTM A615, "Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement."
 2. ASTM C33, "Specification for Concrete Aggregates."
 3. ASTM C39, "Test Method for Compressive Strength of Cylindrical Concrete Specimens."
 4. ASTM C94, "Specification for Ready-Mixed Concrete."
 5. ASTM C114, "Test Method for Chemical Analysis of Hydraulic Cement."
 6. ASTM C138, "Test Method for Unit Weight, Yield, and Air Content of Concrete."
 7. ASTM C143, "Test Method for Slump of Hydraulic Cement."
 8. ASTM C150, "Specification for Portland Cement."
 9. ASTM C156, "Test Method for Water Retention by Concrete Curing Materials."
 10. ASTM C171, "Specification for Sheet Materials for Curing Concrete."
 11. ASTM C173, "Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method."
 12. ASTM C227, "Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations."
 13. ASTM C231, "Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method."
 14. ASTM C260, "Specification for Air Entraining Admixtures for Concrete."
 15. ASTM C309, "Specification for Liquid Membrane-Forming Compounds for Curing Concrete."
 16. ASTM C311, "Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete."
 17. ASTM C387, "Specification for Packaged, Dry, Combined Materials for Mortars and Concrete."
 18. ASTM C494, "Specification for Chemical Admixtures for Concrete."
 19. ASTM C618, "Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete."
 20. ASTM C685, "Specification for Concrete Made by Volumetric Batching and Continuous Mixing."
 21. ASTM C989, "Specification for Ground Iron Blast-Furnace Slag for Use in Concrete and Mortars."
 22. ASTM E154, "Test Methods for Water Vapor Retarders Used in Contact with Earth Under Slabs, On Walls, or as Ground Cover."
 23. ASTM E1155, "Test Method for Determining Floor Flatness and Levelness Using The F-Number System."
 24. ASTM D2240, "Standard Test Method for Rubber Property-Durometer Hardness."
- E. Concrete Reinforcing Steel Institute (CRSI),
1. CRSI "Manual of Standard Practice."

1.04 SUBMITTALS

- A. Product Data:
1. Manufacturers' literature containing product and installation specifications and details.
 2. Where Manufacturer's specifications, recommendations, and/or directions are required by this specification, include Manufacturer's specifications, recommendations, and/or directions.
- B. Shop Drawings: All shop drawings and calculations must bear the seal and signature of an engineer registered in the jurisdiction where project is being constructed.

1. Cast-in-place concrete shown on structural drawings, prepared under the supervision of a registered Professional Engineer, including:
 - a. Rebar placing drawings (ACI 315-99, Detailing Manual SP-66-80 or CRSI MSP-2-81 "Manual of Standard Practice): Show bar sizes, spacing, locations, and quantities of reinforcing and wire fabric and supporting and spacing accessories. Provide steel order lists including bending and cutting details for all reinforcement shown on the structural design drawings. Provide plans showing beam and pier marks associated with schedules.
 - b. Form construction details, including jointing, special formed joints or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually.
 - c. Calculations for any formwork, shoring and/or reshoring.
2. Slab Construction Joint Layout: Unless all concrete control and expansion joints in paving are specifically indicated in Drawings, submit complete joint layout indicating proposed construction joint locations to comply with spacing requirements.
 - a. Location of joints is subject to approval of Architect and Structural Engineer.
3. Concrete Paving Joint Layout: Unless all concrete control and expansion joints in paving are specifically indicated in Drawings, submit complete joint layout indicating proposed construction joint locations to comply with spacing requirements.
 - a. Location of joints is subject to approval of Architect and Civil Engineer.
- C. Concrete design mixes: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- D. Informational Submittals:
 1. Test Reports: Submit the following reports directly to Architect from Testing Laboratory, with copy to Contractor. Prepare reports in conformance with Division 01 Section - Quality Requirements:
 - a. Submit laboratory test reports for concrete materials and mix design test, including certified copy of results of aggregate tested by ASTM C227.
 2. Certificates: Manufacturer's certificate that Products meet or exceed specified requirements.
 3. Qualification Documentation: Submit documentation of experience indicating compliance with specified qualification requirements.
 4. Failure by the contractor to submit the shop drawings, test reports and/or mix designs required above shall release the architect and the engineer from any liabilities due to the negligence on the part of the contractor to comply with the construction documents.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Manufacturer: Company specializing in manufacturing Products specified with minimum 5 years documented experience.
 2. Installer: Company specializing in performing the Work of this Section with minimum 5 years documented experience.
 3. Testing Agency: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 4. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4.

- B. Pre-Installation Meetings: Convene a pre-installation meeting at least one week prior to commencing Work of this Section. Require attendance of parties directly affecting Work of this Section.
 - 1. Review conditions of operations, procedures and coordination with related Work.
 - 2. Agenda shall include the following, as applicable to project scope:
 - a. Tour, inspect, and discuss conditions of concrete work.
 - b. Review concrete testing and their requirements.
 - c. Review required submittals, both completed and yet to be completed.
 - d. Review Drawings.
 - e. Review tolerances and slab flatness requirements.
 - f. Review any special conditions.
 - g. Review requirements for concrete finishes.
 - h. Approve proposed equipment.
 - i. Review and finalize construction schedule related to concrete work and verify availability of materials, personnel, equipment, and facilities needed to make progress and avoid delays.
 - j. Review required inspections, testing, certifying, and material usage accounting procedures.
 - k. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
 - l. Review safety precautions relating to concrete work operations.
 - m. Environmental procedures.
 - 3. General Contractor shall record minutes to include decisions made, action items, and other important points of discussion. Contractor shall distribute minutes to meeting participants, Architect, and other affected parties within 3 business days of the meeting.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Transport, handle, store, and protect Products in accordance with Manufacturers' and Division 01 requirements.
- B. Deliver materials in unopened containers with labels identifying contents.
- C. Store powdered materials in dry area and in manner to prevent damage. Protect liquid materials from freezing.

1.07 PROJECT CONDITIONS

- A. Testing: Owner will engage a qualified testing agency to perform pre-construction testing on concrete mixtures. Contractor shall coordinate construction and testing activities with testing agency as required.
- B. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

- C. Hot-Weather Placement: Comply with **ACI 301** and as follows:
 - 1. Maintain concrete temperature below **90 deg F (32 deg C)** at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:
 - 1. Applied Concrete Technology, Incorporated, Grayslake, IL (800) 228-6694.
 - 2. The Euclid Chemical Company, Cleveland, OH (800) 321-7628.
 - 3. Fortifiber Corporation, Reno, NV (800) 773-4777.
 - 4. ChemREX Inc, Shakopee, MN (800) 433-9517.
 - 5. Master Builders Construction Products, Cleveland, OH (800) 227-3350.
 - 6. Sika Corporation, Lyndhurst, NJ (201) 933-8800, (800) 933-7452.
 - 7. WR Meadows, Hampshire, IL (800) 342-5976.
 - 8. Reef Industries, Houston, TX (800) 231-2077.
 - 9. STEGO Industries LLC, San Juan Capistrano, CA (877) 464-7834.
 - 10. L&M Construction Chemicals, Inc., Omaha, NE (402) 453-6600.
 - 11. Curecrete Chemical Company, Inc., Springville, UT (801) 489-5663.
 - 12. Midwest Floor Care Inc., Lincoln, NE (402) 477-2701.
- B. Division 01 Section - Product Requirements: Product options and substitutions. Substitutions: Permitted.

2.02 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150 - Type I, gray, unless otherwise approved.
 - 1. Assume full responsibility for the quality and soundness of cement. Cement is to be of one type and from the same mill; it is to be of uniform color for all concrete with permanently exposed concrete finishes.
- B. Requirements for concrete to receive densifier / hardener (but not polished): Comply with the most stringent requirements specified herein, or in structural notes, including:
 - 1. Limit fly ash and slag as a replacement for portland cement, as indicated for application.
 - 2. Limit use of curing compounds as indicated.
 - 3. Do not use incompatible admixtures.
- C. Requirements for concrete to receive polished finish: Refer to Division 03, Section "Polished Concrete Floor Finishing", and notes in Structural Drawings as applicable, for additional information and requirements for concrete to receive polished finish. The most stringent requirements shall apply, including but not limited to the following:
 - 1. Air entrainment is not allowed in concrete to receive polished finish.
 - 2. Chemical admixtures, curing compounds, and other topical applications shall be used with concrete to receive polished ONLY IF they are chemically compatible with the polishing products and process and are specifically approved by the Architect and by the polishing system Manufacturer.

- a. Concrete to be polished shall be only wet cured with potable water, unless otherwise approved by Architect.
- 3. Protection Requirements; Refer to Division 3, Section "Polished Concrete Floor Finishing."
- D. Admixtures: The following admixtures are permitted when approved in writing prior to use or are required as specified herein and shall be used in strict accordance with the manufacturer's specifications or recommendations:
- E. Calcium chloride: Conform to ACI 301. The chloride ion level shall not exceed 0.3 percent.
- F. Air-entraining admixtures: ASTM C260 shall be used to achieve the specified air content in all permanently exposed exterior concrete. For steel trowel interior slab finish, do not use air entrainment admixtures and total air entrainment must not exceed 3%. For steel trowel exterior slab finish, comply with ACI 318 and ACI 302.
 - 1. Euclid: AEA-92 or Air Mix 200.
- G. Water-reducing admixtures: Conform to ASTM C494, Type A, containing not more chloride ions than allowed in paragraph C., above.
 - 1. Euclid: Eucon WR series or Eucon MR.
- H. Water-reducing/accelerating admixtures: Conform to ASTM C494, Type C or E having long-term test results showing non-rusting on metal deck and reinforcing steel.
 - 1. Euclid: Accelguard series.
- I. Water-reducing/retarding admixtures: Conform to ASTM C494, Type D containing not more than 1 percent chloride ions.
 - 1. Euclid: Eucon Retarder series.
- J. High-range/water-reducing (HRWR) admixtures: Conform to ASTM C494, Type F or G super plasticizers containing 1 percent maximum chloride ions may be used with low slump (3 inches maximum) concrete to produce flowable concrete (up to 8 inches slump) with early strength gain and 28-day strengths equal to reference concrete. HRWR admixture may be used providing not more than 60 minutes is allowed from addition of admixture to final placement of concrete. HRWR admixture shall be used in concrete with a maximum water/ cement ratio of 0.50 or less and is suggested in the following:
 - 1. In pumped concrete.
 - 2. In concrete topping slabs
 - 3. In lieu of the specified water-reducing admixture (Type A) where confinement of placing due to heavy reinforcement or narrow space requires flowable concrete.
 - 4. Where more than 30 minutes is required between the addition of admixtures to final placement of the concrete, a combination of water-reducing, set controlling admixtures (ASTM C494, Types A, D, & E) as in Master Builders Company "Synergized Performance System" may be used.
 - a. Euclid: Eucon 37 or Eucon 537.
- K. Fly ash or granulated blast furnace slag shall be used as a substitute for 25 percent of Portland cement, except where limited by other applications, including the following:
- L. Certification: Certification of the above requirements is required from the admixture manufacturer prior to mix design review and approval by the Architect. Upon request by the Architect, a qualified representative is to be provided to assure proper use of admixtures. Use of admixtures, other than listed above will be permitted only when approved.

M. Aggregates:

1. Normal-weight concrete - ASTM C33. For slabs, also conform to combined aggregate grading recommendations of ACI 302 and ACI 302.1R, unless otherwise permitted.
2. All concrete exposed to the weather shall conform to the limits of deleterious substances and physical properties of Table 3, ASTM C 33.
3. Local aggregates: Local aggregates not complying with ASTM C33 but which have been shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to the Architect.
4. Maximum size of coarse aggregates: ACI 301.
5. Abrasive aggregates non-slip finishes: Fused aluminum oxide grits, or crushed emery, as abrasive for non-slip finish with emery aggregate containing not less than 40 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof, non-glazing, and unaffected by freezing, moisture, and cleaning materials.

N. Water: Clean and not detrimental to concrete; drinkable.

2.03 FINISHING MATERIALS

- A. Cement Floor Leveling Compound: Camp's "Latex Mix" (Liquid Felt up to 1/8" over 1/8" mix with Portland Cement and Sand), as distributed by the Tichenor Company, Dallas, Texas or approved equal. Floor leveling compound may only be used where floor will not be exposed.

2.04 GROUT / MORTARS

- A. Cement grout: Conform to ASTM C387 "Dry packaged mixtures" or:
1. Mix at the site, in composition of one volume of Portland cement to 2-1/2 volumes of fine aggregate.
 2. Mix the materials dry; then add sufficient water to make the mixture flow under its own weight.
 3. Submittals: The following laboratory test results shall be submitted to show compliance with the requirements of this specification:
 - a. Initial setting time: 8 hours maximum
 - b. Vertical shrinkage: 0
 - c. Compressive strength: 5000 psi 7 days
 - d. Compressive strength: 7000 psi 28 days
 4. Field service: When required by the Architect, provide a qualified concrete technician employed by the Grout Manufacturer to assist in the initial grouting operations.
 - a. Euclid: NS Grout or Hi Flow Grout or E3 Grout series.
 - b. Sika: Sika Grout #212.

2.05 CURING MATERIALS

- A. Method of curing shall be approved by the finish flooring applicator where finishes are indicated.
- B. Wet Cure Blanket: Waterproof covering, for curing exposed finish concrete floors, shall be non-staining, reinforced with fibers, and conforming to the requirements of the current edition of ASTM C171-03, ASTM C171-97a, and AASHTO M171-00, standard specifications for sheet material for curing concrete slabs. McTech Group, Inc.; "UltraCure NCF", Loganville, GA (866) 913-8363, or comparable product by another Manufacturer.
- C. Curing Compounds:

1. For Slabs not scheduled for Chemical Hardener: Clear Bond as made by Guardian Chemical Co., Acry-Seal as made by Toch Bros., Dress and Seal as made by L & M Construction Chemicals, MasterKure as made by Sonneborn, or Res-X Cure by Burke Concrete Accessories.
 2. For Slabs to be Chemically Hardened: Do not use film-forming curing compounds. Where curing compound is required, a non-film-forming curing compound chemically compatible with the hardener may be used, if first approved by the chemical hardener Manufacturer. Dissipating liquid membrane-forming compounds for curing concrete; Conform to ASTM C309, Type 1. Curing compound shall be compatible with floor sealer or finish used. Low VOC. At polished concrete finishes, use of curing compounds is not allowed unless specifically approved by the Architect and polishing system Manufacturer.
 - a. Euclid: VOX Kurex DR series; waterborne products.
 - b. W.R. Meadows: 1100 series.
 - c. L&M Construction Chemicals: Cure R.
 - d. Division 01 Section - Product Requirements: Product options and substitutions. Substitutions: Permitted.
- D. Evaporation retarder: "MasterKure ER 50" by BASF or equal; spray applied liquid film for hot weather finishing.
1. Do not use evaporation retarder at slabs to be densified, unless specifically approved for compatibility by the densifier manufacturer.
- E. Water: Potable.

2.06 SEALERS AND DENSIFIER / HARDENERS

- A. Exterior Sealers: applied to horizontal concrete surfaces permanently exposed to salts, deicer chemicals and moisture, including parking decks. The manufacturer shall provide a 5-year labor and materials Warranty on performance of the sealer. Sealer shall be compatible with the curing compound used.
1. Euclid: Eucoguard or Diamond Clear or Super Diamond Clear.
 2. ChemREX: Hydrozo Clear 40.
 3. Substitutions: Permitted.
- B. Floor Sealing Compound: "Master Seal 330" by Master Builders, Cleveland, Ohio or approved equal.
- C. Concrete Densifier / Sealer for Interior Concrete: Coordinate requirements of hardener/densifier products with concrete mix designs and chemical admixtures and curing methods. These products are chemically reactive with the free lime in concrete and performance and appearance will be adversely affected by chemicals that react with lime or that impede the ability of the hardener/densifier to react. Do not use chemical admixtures or curing compounds unless specifically approved in writing.
1. Exposed concrete floor slabs, not indicated for polished finish or with light broom finish: Two- or Multiple-Coat, spray-applied, hardener/densifier. Chemical reactive magnesium fluorosilicate formulation with chemical resistant properties to alkali, acids, oils and salts, and does not substantially change appearance of concrete surfaces. Provide one of the following or approved equal product by another Manufacturer:
 - a. BASF; "MasterKure HD 300 WB".
 - b. Euclid Chemical Co; "Surf-Hard".
 2. Exposed concrete floor slabs with smooth troweled finish: One coat flood-applied, hardener/densifier. Chemical reactive silicate / siliconate formulation that enhances sheen level of troweled concrete and is designed to maintain or increase sheen level over time with normal wear. Provide one of the following or approved equal product by another Manufacturer:
 - a. CureCrete Chemical Company; "Ashford Formula", www.ashfordformula.com.
 - b. Dayton Superior; "Sure-Hard Densifier J17", www.daytonchemical.com.

- c. Euclid Chemical Company; "Euco Diamond Hard", www.euclidchemical.com.
 - d. L&M Construction Chemicals: "Seal Hard", www.lmmc.com.
3. Refer to Division 03 "Polished Concrete Floor Finishing" for floor polishing system.

2.07 JOINTS AND EMBEDDED ITEMS:

- A. Construction and Contraction Joints: Comply with ACI 301 and recommendations of ACI 302.1R. Sealant shall be two-part semi-rigid epoxy, and shall have minimum Shore A Hardness of 80 when measured with ASTM D2240. A product that complies with these requirements is "Euco 700", as manufactured by The Euclid Company, Cleveland, OH (800) 321-7628.
- B. Isolation Joints: Fillers shall consist of 1/8 inch width strips of neoprene, synthetic rubber, or approved substitute, extending the full depth of the slab. Sealant shall be two-part elastomeric type, polyurethane base.

2.08 MISCELLANEOUS MATERIALS

- A. Expansion Joint Material: Preformed expansion joint material conforming to ASTM D-1751.
- B. Drilled Anchor Bolts: Shall be "Titen HD" bolts as manufactured by Simpson Strong-Tie.; "Kwik HUS-EZ", by Hilti Fastening Systems; or approved equal.
- C. Rust Inhibitor: For field application to metal accessories shall be Hi-Build Epoxoline manufactured by the Tnemec Co., Inc., Kansas City, Missouri or approved equal.
- D. Epoxy for Patching: Shall be a two-component polymer modified cementitious system equal to Sikatop series as manufactured by Sika Chemical Corp., Lyndhurst, New Jersey or approved equal. Sikatop product selected shall be appropriate for intended repair and shall be approved by Architect.
- E. Accessories: AC315 Galvanized chairs, stools, spacers, etc. shall be by Superior Manufacturing Co., or equal.
- F. Waterstop: Preformed flexible PVC CRD-C-572-74. waterstop for embedding in concrete to prevent passage of fluids through joints. Factory-fabricate corners, intersections and directional changes. Acceptable manufacturers include:
 - 1. Sika Corporation
 - 2. W. R. Meadows
 - 3. Or approved equal.

2.09 VAPOR RETARDER

- A. Provide cover over prepared soil, below aggregate base material at slabs-on-ground and over void forms unless otherwise noted on the plans. Use only materials which are resistant to decay when coated in accordance with ASTM E154.
- B. Vapor Retarder: Class A, Polyethylene sheet not less than 10 mils thick, Acceptable manufacturers include:
 - a. Stego Industries
 - b. Fortifiber Building Systems Group

- c. Raven Industries
- d. Or approved equal.

2.10 PROPORTIONING

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If laboratory trial batch method is used, use an independent testing facility acceptable to Architect for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing and inspection unless otherwise acceptable to Architect.
- B. Submit written reports to the testing laboratory of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed and approved. Include the following information for each concrete mix design:
 - 1. Method used to determine the proposed mix design.
 - 2. Gradation of fine and coarse aggregates, plus combined aggregate gradation for slabs, ACI 302.
 - 3. Proportions of all ingredients including all admixtures added either at the time of batching or at the job site.
 - 4. Water-cement ratio.
 - 5. Slump, ASTM C143.
 - 6. Certification of the chloride content of individual admixtures and of the mixes as proposed.
 - 7. Air Content: ASTM C173 (Volumetric Method).
 - 8. Unit weight of concrete, ASTM C138.
 - 9. Strength at 4, 7, and 28 days, ASTM C39.
 - 10. Method of recording batch proportions.
 - 11. Substantiating test reports.
- C. Concrete types and strengths: Minimum 28 Day Compressive Strength shall be per design requirements but not less than:
 - 1. Slabs on ground, walls, drilled piers: 3,000 psi.
 - 2. Slabs on void forms: 4,000 psi
 - 3. Normal or Lightweight concrete on metal deck: 3,000 psi.
 - 4. All concrete exposed to weather shall be air entrained (ASTM C260).
 - 5. All concrete shall be normal weight unless noted otherwise.
Also, see general and specific notes on structural drawings.
- D. Weights: All concrete shall be normal-weight concrete unless otherwise designated on the structural drawings.
- E. Durability: Conform to ACI 301.
 - 1. All concrete exposed to potentially destructive weathering, such as freezing and thawing, or to de-icer chemicals is to be air-entrained, $4.5\% \pm 1.5\%$, six sacks cement/cu. yd. min., 4" max. slump.
 - 2. Water-cement ratio: For concrete subject to freezing and thawing or deicer chemicals, the water-cement ratio shall not exceed 0.53 by weight including any water added to meet specified slump in accordance with the requirements of ASTM C94 unless otherwise noted.
- F. Slump: Conform to ACI 301.
 - 1. 4 ½ inch maximum for consolidation by vibration
 - 2. 5 inch maximum for consolidation by other methods

3. 8 inch maximum for flowable concrete. Concrete containing HRWR admixture (super plasticizer): 3 inch maximum before addition of HRWR
 4. Where field conditions require slump to exceed that specified above, the increased slump shall be obtained by the use of a superplasticizer only, and the Contractor shall obtain written approval from the Architect who may require an adjustment to the mix.
- G. Production of concrete: Conform to ACI 301:
1. Ready-mixed concrete:
 - a. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C94.
 - b. All concrete shall be proportioned conforming to the approved mix designs and of the materials contained in those approved mixes. A certified copy of the design weights for each mix shall be kept at the producing plant for each class of concrete used on the project.
 - c. Plant equipment and facilities are to conform to the "Check List for Certification of Ready - Mixed Concrete Production Facilities" of the National Ready-Mixed Concrete Association and have NRMCA or approved certification within the past year.
 2. All other concrete: Conform to ACI 301
 3. Concrete produced by on-site volumetric batching and continuous mixing if approved shall conform to ASTM C685.
 4. Use of accelerating admixtures in cold weather and retarding admixtures in hot weather shall not relax placement requirements specified herein.
 5. Admixtures: ACI 301. All concrete placed at ambient temperatures below 50°F is to contain an approved accelerator. All concrete placed at ambient temperatures above 80°F is to contain an approved retarder. All concrete required to be air-entrained is to contain an approved air-entraining admixture. When improved workability, pumpability, lower water-cement ratio, or high ultimate and/or early strength is required, the HRWR admixture (super plasticizer) may be used.
 6. Ensure air content for slabs with steel trowel finish is less than 3%. The concrete shall be of such consistency and composition that it can be worked readily into the corners and angles of the forms and around reinforcement without permitting materials to segregate or free water to collect on the surfaces. Within the limiting requirements, adjust the consistency of the concrete as may be necessary to produce mixtures which will be placeable with reasonable methods of placing and compacting. Maintain on the job at all times adequate extra cement to be used at rate of 1/2 sack cement per cubic yard concrete for each 2" slump increase for corrections due to wetness desired or obtained. No water shall be added to concrete except under the direct awareness of the project inspector.
 7. Adjustments to concrete mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant at no additional cost to Architect. Laboratory test data for revised mix design and strength results must be submitted and accepted before using in work.

2.11 FORMWORK

- A. Division 03 Section - Concrete Forms and Accessories

2.12 REINFORCING MATERIALS

- A. Division 03 Section - Concrete Reinforcement

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Division 01 Section - Execution Requirements: Verification of existing conditions before starting work.
- B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.
- C. Report in writing to Architect prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.
- D. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.02 INSTALLATION - GENERAL

- A. Install all cast-in-place concrete work in accordance with ACI 301 except as herein specified.

3.03 INSTALLATION - FORMWORK

- A. Division 03 Section - Concrete Forms and Accessories
- B. Construction and Contraction Joints: Conform to ACI 301 and recommendations of ACI 302.1R.

3.04 REINFORCEMENT

- A. Placement: Division 03 Section - Concrete Reinforcement

3.05 CONCRETE (CONVEYING AND DEPOSITING)

- A. Placement: Conform to ACI 301:
 - 1. Maintain concrete cover around reinforcing as specified herein and ACI 301.
 - 2. Pumping concrete: ACI 304.2-R.
 - 3. Cold-Weather Placement: Comply with provisions of ACI 306.1 "Standard Specifications for Cold-Weather Concreting" and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 4. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
 - a. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - b. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
 - 5. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305R "Standard Specification for Hot-Weather Concreting" and as specified.
 - a. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

- b. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
 - c. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
 - d. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.
- B. Protection of cast concrete: Conform to ACI 301.
- C. Where the use of synthetic fibers is specified, fibers shall be added at a rate of 5.0 million fibers per cubic yard.
- D. Repair of surface defects: ACI 301.
 - 1. Inspect concrete surfaces immediately upon removal of forms. Patch imperfections as needed or as directed by the Architect.
 - 2. Modify or replace concrete not conforming to required thickness, lines, details, and elevations.
 - 3. Repair or replace concrete with excessive honeycombing and other defects due to improper placement. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.
 - 4. Tie holes shall be filled solid with patching mortar.

3.06 FINISHING

- A. Finishing of formed surfaces: ACI 301:
 - 1. Tops of forms:
 - a. Strike concrete smooth at tops of forms.
 - b. Float to texture comparable to formed surfaces.
 - 2. Formed surfaces:
 - a. Permanently exposed surfaces and surfaces to be painted: ACI 301 - "Smooth Form Finish" with the fins ground smooth and air holes or honeycomb filled with mortar.
 - b. Surfaces in unfinished areas unexposed to public view: ACI 301- "Rough Form Finish".
- B. Slabs: Minimum slab surface tolerance must satisfy ACI 301 and ACI 302.1R as measured in accordance with ASTM E1155.
 - 1. Slabs-on- ground:
 - a. Preparation of sub-grade: Compact stone base aggregate to thickness indicated on drawings. Roll poof stone screenings topping to provide smooth hard surface on which to place slab. Surface should not show footprints or truck tracks when driven over.
 - b. Place floor slabs-on- ground by "strip cast" method. Contraction joints where shown on drawings shall be saw-cut (as soon as slab has set enough to allow working on but not before it has set enough to prevent raveling) 1/4 of the depth of slab thickness. It is recommended to use a SOFF-CUT saw and blades (between 1 to 4 hours after finish typically with 1 inch minimum depth) for all contraction joints as per manufacturer recommendations.
 - c. For exposed slabs, install semi-rigid epoxy sealant in construction and contraction joints after slab has fully dried.
 - d. Separate slabs-on- ground from vertical surfaces with 1/2 inch-thick joint filler. Extend joint filler from bottom of slab to within 1/8 inch of finished slab surface.

- e. Allowable tolerance for slab on grade surfaces, measured in accordance with ACI 117 and ASTM E1155, shall meet or exceed an overall value of FF35/FL25, with minimum local value of FF24/FL17.
- 2. Suspended Floor Slab:
 - a. Minimum surface tolerances: FF25 & FL20 overall FF20 & FL15 local.
- C. Float Finish:
 - 1. Locations: All concrete surfaces under mud-set tile or pavers.
 - 2. Finishing: After concrete has stiffened sufficiently and bleed water has evaporated, the surface shall be wood floated to produce a uniform texture with no coarse aggregate visible. Apply sufficient pressure to bring the moisture to the surface.
- D. Trowel Finish:
 - 1. Locations: All concrete surfaces under:
 - a. Thin set tile
 - b. Carpets
 - c. Vinyl floor tile
 - d. Exposed concrete
 - e. Typical unless noted otherwise
 - 2. Troweling: Steel trowel not less than two passes. Begin troweling with power trowel as soon as little or no cement sticks to the blades. Dusting with dry cement or aggregate to stiffen mix or absorb moisture is not allowed. The concrete shall then be hand troweled or machine troweled to produce a smooth impervious surface for the purpose of burnishing.
- E. Broom Finish:
 - 1. Locations: Exterior stairs, ramps, walks and other locations where noted on the drawings.
 - 2. Finishing: Same method as specified for trowel finish, except after initial troweling brush concrete surfaces with a soft brush or broom to texture as specified by the architect.
- F. Power Machine Finishing: In place of hand finishing, the Contractor may use a power machine approved by the Architect for finishing the concrete surfaces for finishing the concrete surfaces. However, the preparation of concrete surfaces for finishing by machine shall be, in general, as hereinbefore required for hand finishing.
- G. Non-slip Finish: Apply abrasive aggregate at the rate of 25 lbs. per 100 SF per manufacturer's instructions in areas specified.

3.07 CURING AND PROTECTION

- A. Protect all freshly placed concrete from washing by rain, flowing water, etc. Do not allow concrete to dry out from the time it is deposited in the forms until the expiration of the curing period hereinafter specified. The methods of curing shall be as specified in the following paragraphs, unless otherwise authorized by the Architects.
- B. Concrete surfaces, not otherwise specified, shall be cured by being kept wet with clean water for a period of not less than seven (7) days after placing. Each day the forms are left in place and kept wet enough to prevent the opening of joints in the forms and the drying out of the concrete, will be counted as one (1) day of curing.
- C. In lieu of the wetting specified above, the Contractor may, use a non-bituminous liquid sealing and curing compound to seal the moisture in the concrete. Such material shall not, however, be applied to surfaces which are to receive further concrete, mortar, resilient tile or liquid vinyl coating. Curing liquid, if used, shall be applied in conformity with the recommendations of the

manufacturer of the material approved for use, and to sufficient extent to effectively hold the moisture in the concrete. The use of such material shall not relieve the Contractor of the responsibility of protecting all floor slabs, platforms, and steps whenever any scaffolding, shoring, form work, masonry, concrete or other work is being done over or above finished concrete slabs.

- D. Permanently exposed concrete floors shall be cured by covering the entire surface, as soon as practical after finishing, with waterproof paper, laid with four-inch (4") lapped joints. The joints shall be covered with gummed tape or be glued with waterproof glue. Such covering shall remain in place until completion of the building, except on surfaces where ceramic tile is to be applied, in which cases the covering shall be removed after a period of seven (7) days has elapsed after the placing and finishing of the concrete. Tears in paper shall be repaired.
- E. Imperfect or damaged work, or any material damaged or determined to be defective before final completion and acceptance of the entire job, shall be satisfactorily replaced at the Contractor's expense, and in conformity with all of the requirements of the Drawings and Specifications. Removal and replacement of concrete work shall be done in such manner as not to impair the appearance or strength of the structure in any way.
- F. Cleaning: Upon completion of the work, all forms, equipment, protective coverings and any rubbish resulting therefrom shall be removed from the premises. Finished concrete surfaces shall be left in a clean condition, satisfactory to the Owner. After sweeping with an ordinary broom and removing all mortar, concrete droppings, loose dirt, mud, etc., wash all concrete floors and platforms with soapsuds and scrub with a stiff fiber brush. Mop up the suds and flush the surfaces with clean water. Provide adequate measures during scrubbing, mopping, and flushing operations to keep excessive or injurious amounts of water off resilient tile floors. Any damage to such floors shall be promptly, effectively and satisfactorily repaired.

3.08 PATCHING AND REPAIR

- A. Comply with ACI 301 and ACI 503.2 for standard specifications for bonding plastic concrete to hardened concrete with a multiple component epoxy adhesive.
- B. Remove honeycomb voids, cracks, and irregularities. Where repair is required, cut back defects not less than 1/2" with square edges, brush out, drench with water and fill with concrete of same mix from which coarse aggregate is removed. When cut-outs have been filled, trowel surface smooth, remove excess grout and after set, grind slightly to uniform color and appearance using neat Portland Cement applied with a power grinder wheel.

3.09 GROUTING

- A. After steel columns have been installed and leveled, grout the space between the bottom of the plate and concrete, using cement grout completely filling the space and forming solid bearing for the column base plate.

3.10 EVALUATION AND ACCEPTANCE OF CONCRETE

- A. Comply with ACI 301.

3.11 ACCEPTANCE OF STRUCTURE

- A. Comply with ACI 301.

3.12 MISCELLANEOUS CONCRETE

- A. Curbs: Provide monolithic finish to interior surface of curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- B. Equipment bases and foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment with template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

3.13 FIELD QUALITY CONTROL

- A. Materials and operations shall be tested and inspected as work progresses. Failure to detect defective work shall not prevent rejection when defect is discovered, nor shall it obligate the Architect for final acceptance.
- B. Testing agencies shall meet the requirements of "Recommended Practice for Inspection and Testing Agencies for Concrete and Steel in Construction" ASTM E 329.
- C. The following testing services shall be performed by the testing laboratory:
 - 1. Secure concrete samples in accordance with "Method of Sampling Fresh Concrete" ASTM C172-
 - 2. Mold and cure four specimens from each sample in accordance with "Method of Making and Curing Concrete Compression and Flexural Specimens in the Field" ASTM C31-. The cylinders shall be stored in the field for 24 hours and then transported to the laboratory to be cured.
 - 3. Test specimens in accordance with "Method for Test for Compressive Strength of Molded Concrete Cylinders" ASTM C39-. Two specimens shall be tested at 28 days for acceptance and one shall be tested at 7 days for information. One specimen shall be held for future testing, if required.
 - 4. Make one strength test (four cylinders) for each 100 cu. yd. or fraction thereof, of each mix design of concrete placed in any one day.
 - 5. Determine total air content of air entrained normal weight concrete for each strength test in accordance with ACI 231.
 - 6. Report test results in writing to the Architect and Structural Engineer on the same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of contractor, name of concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day test and 28-day tests, air content.
 - 7. Determine slump for each strength test and whenever consistency of concrete appears to vary, using "Method of Test for Slump of Portland Cement Concrete" ASTM C143.
 - 8. Determine temperature of concrete sample for each strength test.
- D. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained. Test to determine adequacy of concrete will be by cored cylinders complying with ASTM C42. Contractor shall pay for such test conducted, and any other additional testing as may be required, when unacceptable concrete is verified.
- E. Monitor the addition of water at the jobsite and the length of time concrete is allowed to remain in the truck before placement.
- F. Testing non-shrink grout: Make one strength test for every 10 baseplates grouted.

- G. The Contractor shall provide and pay for the necessary testing services of the following:
1. Qualification of proposed materials and the establishment of mix designs in accordance with "Building Code Requirements for Structural Concrete" ACI 318.
 2. Other testing services needed or required by the Contractor.
- H. To facilitate testing and inspection, the contractor shall:
1. Furnish necessary labor to assist testing agency in obtaining and handling samples at the job site.
 2. Advise the testing agency in advance of operations to allow for the assignment of testing personnel and testing.
 3. Provide and maintain for the use of the testing agency adequate facilities for proper curing of concrete test specimens on the project site in accordance with "Methods of Making and Curing Concrete Compression and Flexural Specimens in the Field" ASTM C31.
- I. Evaluation and acceptance:
1. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed specified strength and no individual test result (average of two cylinders) is below specified strength by more than 500 psi.
 2. Completed concrete work will be accepted when the requirements of "Specifications for Structural Concrete for Buildings" ACI 301, Chapter 18 have been complied with.
 3. In any case, where the average strength of the laboratory control cylinders, as shown by the tests for any portion of the structure, falls below the minimum specified ultimate compressive strength, the Architect shall have the right to require the Contractor to provide improved curing conditions of temperature and moisture to secure the required strength. Also, if the average strength of the laboratory control cylinder should fall so low as to cause the portions of the structure to which the respective unsatisfactory test reports apply to be in question by the Architect, the Contractor shall follow the core procedure set forth in the current edition of ASTM C42. If the results of the core tests indicate, in the opinion of the Architects, that the strength of the structure is inadequate, such replacement, load testing, or strengthening as may be ordered by the Architects shall be provided by the Contractor without cost to the Owner.
- J. Reports: The testing laboratory shall make reports to the following:
- Concrete supplier - 1 copy
 - Contractor - 1 copy
 - Owner - 1 copy
 - Architect - 1 copy
 - Structural Engineer - 1 copy
1. Reports shall be made and distributed immediately after the respective tests or inspections are made.
 2. Where reports indicate deviations from the Contract Documents, they shall also include a determination of the probable cause of the deviation and where applicable, a recommendation for corrective action.
 3. Wherever the testing laboratory recognizes a trend of decreasing quality in the concrete due to changing reasons, conditions of curing or other cause; this shall be brought to the attention of the Architect, along with a recommendation for corrective action to be taken before the materials fall below the requirements of these Specifications.
- K. Authority & Responsibilities of the Testing Laboratory

1. The laboratory representative shall immediately notify the Architect and the Contractor of any deviance from Specifications and approved design mixes observed at the mixing plant or the job site.
2. If, in the opinion of the laboratory representative, the deviance observed will be probable cause for subsequent rejection of the material, he shall so inform the Contractor and Architect so that a timely decision as to whether or not to continue operations can be made.
3. Subsequent to on-the-spot verbal notification, the laboratory shall file a written report of any deficiencies or deviance noted including a summary of conversations and decisions made and action taken at the time in accordance with Paragraph 1.
4. The testing laboratory shall control field adjustments made to concrete mixes to compensate for field conditions and report same in accordance with Paragraph H.

END OF SECTION 03 3000

SECTION 22 0500
COMMON WORK REQUIREMENTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. See General Conditions and Supplementary Conditions.
- B. The requirements listed under General Conditions and Supplementary Conditions and the General Requirements are applicable to this section and all subsequent Sections of Division 22 and form a part of the contract.
- C. See Division 23 for Heating, Ventilating & Air Conditioning (HVAC) Systems.
- D. See Division 26 for Electrical Systems.
- E. All electrical work, regardless of voltage which is provided under Division 22 shall comply with the requirements of the National Electric Code (NEC) and Division 26.

1.2 SCOPE OF WORK

Provide all labor, materials, tools, machinery, equipment, supplies, transportation, storage, utilities, appliances, drayage, hauling, hoisting, excavation, backfill, supervision, and services necessary to complete the Plumbing work under this Contract. Pay all fees, tap charges, meter charges, permits, licenses, inspections, and special fees assessed by the local utilities and local authorities having jurisdiction. Coordinate work with the work of the other trades so as to resolve conflicts without impeding job progress.

Examine the Architectural, Structural, Mechanical, Plumbing, and Electrical Drawings and other Divisions, and Sections of the Specifications in order to determine the extent of Work required to be completed. Failure to examine all the Contract Documents for this Project will not relieve the Contractors of the responsibility to perform all the Work required for a complete, fully operational and satisfactory installation.

The work includes but is not limited to the following systems, equipment, and services:

- 1. Tagging and identification of equipment, valves, piping, and conduit, etc.
- 2. Packaged electric generating system.
- 3. Connection of all equipment furnished under other Divisions and/or by the Owner.
- 4. All water services for the building.
- 5. All sewer services for the building.
- 6. All electric services for the building.
- 7. Furnishing of Shop Drawings, Product Data and Samples.
- 8. Furnishing of Record Drawings.
- 9. Start-up, testing, balancing, and adjusting of systems as specified in this Division.
- 10. Furnishing of operating and maintenance books.
- 11. Miscellaneous items as required for complete and functioning systems as specified, as indicated on the Drawings, and as required.
- 12. All systems, equipment, and services specified shall be furnished and installed complete and ready to use.

1.3 CODES AND PERMITS

- A. If applicable, the fire suppression shall be performed in strict accordance with the applicable provisions of the International Building Code, 2021 Edition; the International Plumbing Code, 2021 Edition; the International Mechanical Code, 2021 Edition and the International Fire Code, 2021 Edition as adopted and interpreted by Williamson County and the National Fire Protection Association (NFPA Regulations), current adopted edition, regarding fire protection, heating and ventilating and air conditioning systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Architect and Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.
- B. Permits necessary for performance of the work shall be secured and paid for by the Contractor. All utility connections, extensions, and tap fees shall be paid for by the Contractor, unless otherwise specified herein.
- C. The following lists some applicable codes and standards that shall be followed.
- Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances.
 - National Electrical Code
 - Underwriters Laboratories, Inc. Standards
 - American National Standards Institute
 - American Society for Testing Materials Standards
 - Standards and requirements of local utility companies.
 - National Fire Protection Association Standards including but not limited to NFPA-1, NFPA-101, NFPA-13
 - American Society of Mechanical Engineers Boiler and Pressure Vessel Codes
 - Occupational Safety and Health Act
 - Commercial and Industrial Insulation Standards (MICA)
 - American Gas Association
 - The American Society of Sanitary Engineering

1.4 RECORD DRAWINGS

- A. The Contractor shall be responsible to maintain a complete and accurate set of marked up drawings showing information on the installed location and arrangement of all plumbing work, and in particular, where changes were made during construction. The Contractor shall be responsible for keeping record drawings accurate and up to date throughout the construction period. The Contractor shall include copies of all addenda, RFI's, bulletins, and change orders neatly attached to record drawing set.
- B. After installation and acceptance of direct buried underground piping and service lines in trenches, the Contractor shall take 'as-built' measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check offline locations. Definite measurements shall be taken for each service line. The location of buried piping and trench service lines shall be shown on the drawings and dimensioned from fixed points.

1.5 QUALIFICATIONS

- A. All mechanics shall be skilled in their respective trade.
- B. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

1.6 QUALIFICATION PROCEDURES

- A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements.

1.7 HAZARDOUS CONDITIONS

- A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.8 HAZARD SIGNS

- A. Equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments shall include signs on all doors entering such spaces that shall read similar to the following: "Hazardous Area - Authorized Personnel Only."
- B. Confined Spaces: Areas designated by OSHA Standard 1910.146 as a confined space shall be marked with a sign that reads "Confined Space - Entry by authorized personnel only, by permit."
 - 1. "Confined Space" means a space that:
 - a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
 - b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
 - c. Is not designed for continuous employee occupancy.
- C. The Contractor shall survey the final premises to determine where any such potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.9 SUBMITTALS

- A. The Contractor shall submit submittal brochures of all equipment, fixtures and materials to be furnished under Division 22, including but not limited to the following:
 - 1. Piping materials, valves, insulation materials and installation methods, vibration isolation devices, pipe penetration installation methods and products for fire rated assemblies, and all plumbing equipment listed on equipment schedules, and in related construction documents.
 - 2. Materials, certification, shop drawings, and other information as specified in the

individual Division 22 Specification Sections within this Specification.

- B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.
- C. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.
- D. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.
- E. Submittals and one resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.
- F. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter.
- G. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Any relocation of plumbing and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.
- H. Shop drawings will be returned unchecked unless the following information is included: cover sheet shall be provided for each submittal of equipment, products and material proposed for use on the project. A common cover sheet for similar equipment (example: all air handling units or all fire protection products) is acceptable. The cover sheet shall list equipment by symbol number; reference all pertinent data in the Specifications or on the drawings; provide size and characteristics of the equipment, name of the project and a space large enough to accept a review stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings. Cover sheet shall clearly identify any deviations from the

specifications for submitted equipment, products, and materials.

- I. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

J.If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted for review with the shop drawing submittals of the substitution. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.10 COORDINATION DRAWINGS

- A. The Contractor shall, in advance of the work, prepare coordination drawings for:
 - 1. Equipment rooms, and other spaces housing plumbing and lab gas systems equipment, etc.
 - 2. Piping and chases.
 - 3. Complete plumbing piping systems located within the building.
 - 4. Layout of all plumbing equipment.

Show the location of piping openings through the building floors, walls and roofs coordinated with Architectural and Structural, as well as the location and elevations of building fire suppression equipment and systems, including piping, coordinated with HVAC, controls, plumbing, fire suppression, fire alarm, and electrical systems. Coordination drawings, including plans, elevations and sections, as appropriate, shall clearly show the manner in which the plumbing systems fit into the available space and coordinates with HVAC and plumbing equipment, ductwork, piping, sprinkler heads, and electrical equipment, including conduits, light fixtures, motor control centers, transformers, panels, variable frequency drives, etc. Drawings shall demonstrate required code clearances for mechanical and electrical equipment, control panels, etc., and proper operation, maintenance and replacement of plumbing devices and equipment. Coordination drawings shall be of appropriate scale to satisfy the previously stated purposes, but not smaller than 1/8-inch scale for floor plans and 1/4 scale of equipment rooms and chase areas. Drawings may be composite or may be separate but fully coordinated drawings of the same scale. Every subcontractor must sign-off on coordination drawings prepared by each craft. Failure to sign-off will indicate that subcontractor is proceeding at his own risk. Any cost required to relocate systems to comply with required clearance and equipment installation requirements shall be provided by the Contractor without additional cost under the contract.

- B. Coordination drawings shall be submitted prior to the scheduled start of the work in the area illustrated by the drawings, for the purpose of showing the Contractor's planned method of installation. The objectives of such drawings are to promote carefully planned work sequence and proper coordination, in order to assure the expeditious solutions of problems, and the installation of lines and equipment as contemplated by the contract documents while avoiding or minimizing additional costs to the Contractor and to the Owner.
- C. In the event the Contractor, in coordinating the various installations and in planning the method of installation, finds a conflict in location or elevation of any of the plumbing

systems, with the structural items or with other construction items, such conflicts shall immediately be documented and submitted for clarification. In doing so, the Contractor shall explain the proposed method of solving the problem or shall request instructions as to how to proceed if adjustments beyond those of usual trades coordination are necessary.

- D. Installation of plumbing work shall not proceed prior to the submission and completion of the review of the coordination drawings, and any conflicts which are disclosed by the coordination drawings. It is the responsibility of the Contractor to submit the required drawings in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time.

1.11 USE OF BIM OR CAD FILES

- A. Under certain conditions, the Contractor will be permitted the use of the Engineer's BIM or CAD files for documentation of as-builts, submittals, or coordination drawings.
- B. The Engineer may require compensation for the time necessary to format the CAD files delivery to the Contractor. Such work will include removal of title blocks, professional for seals, calculations, proprietary information, etc.
- C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for BIM or CAD file usage.

1.12 PRIOR APPROVAL

- A. Identification of Division 22 equipment, and materials listed within this specification and in the Equipment Schedules on the drawings, which are identified by Manufacturer's Name, Trade Name, and/or Model Numbers are generally not meant to give preference to any manufacturer but are provided to establish the design requirements and standards. Additional manufacturers may be submitted utilizing the Substitution Request Form. Engineer will make final determination if the substitution is accepted.
- B. Requests for proposed substitutions shall be accompanied with catalog and technical data. Actual equipment components and options shall be highlighted and any discrepancies with the specified equipment noted.
- C. Requests for proposed substitutions for unspecified Division 22 major items of equipment, and materials shall be submitted by the manufacturer, supplier, and/or sub-contractor for review. Division 22 prior approval requests shall be submitted and received not later than ten (10) calendar days prior to the bid date.
- D. Requests for prior approval received after the specified due date may not be considered.

1.13 GUARANTEE-WARRANTY

- A. The following guarantee is a part of the specifications and shall be binding on the Contractor:
"The Contractor guarantees that this installation is free from defects. He agrees to replace or repair any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner,

whichever occurs first; such date will be determined in writing, by means of issuing a 'Certificate of Substantial Completion', AIA Form G704", or equivalent.

- B. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.
- C. All items of plumbing equipment shall be provided with a minimum of one (1) year parts and labor warranty, from the date of acceptance by the Owner.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

- A. All equipment and materials shall be new and shall be the standard product of manufacturers regularly engaged in the production of plumbing equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

2.2 ALTITUDE RATINGS

- A. Unless otherwise noted, all specified equipment capacities are for an altitude of 350 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 ELECTRICAL WIRING AND CONTROL EQUIPMENT

- A. All wiring and conduit shall be furnished and installed as scheduled in Section 22 0549 unless otherwise noted or directed.
- B. The Contractor shall coordinate completely with all trades and Sub-Contractors as required to ensure that all necessary components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

2.4 PAINTING

- A. All finish painting of plumbing systems and equipment will be under "Painting," unless equipment is hereinafter specified to be provided with factory applied finish coats.
- B. All equipment shall be provided with factory applied prime finish, unless otherwise specified.
- C. All exposed plumbing piping outside of mechanical rooms shall be painted. Refer to Division 9 for additional Paint information.
- D. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished.

2.5 IDENTIFICATION OF VALVES

- A. All new valves shall be provided with a stamped metal tag secured to the valve. Tag shall indicate the valve number, the service and function of each valve. The Contractor shall furnish two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Submitted drawings shall be neat and easily readable. In

addition, the Contractor shall provide a valve chart, typed neatly on 8-1/2" x 11" sheets, listing the number, size, location, function, normal operating position, on each valve installed under Division 21. Tags shall be stamped brass 1-1/2" diameter and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

- B. Division 22 valve tags shall be coordinated with Division 21 and Division 23 valve tags for coordinated format between each Division.

2.6 PIPING SYSTEM IDENTIFICATION

- A. Means of Identification: All piping and duct systems installed as part of this project shall be identified by each of the means described below. The Contractor shall provide shop drawing submittal data for proposed labeling system materials and manufacturer's recommended installation procedures.
- B. Piping Systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as shown on the drawings. Color coded banding shall also be provided. Additionally, an arrow shall be included to indicate the direction of flow through the pipe.
- C. Locations of Piping System Identification: The identifying legends and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:
- Adjacent to each valve in piping system.
 - At every point of entry and exit where piping passes through a wall.
 - On each pipe riser and junction.
 - At a maximum interval of 20 feet on pipelines exposed and concealed above accessible ceilings.
 - Adjacent to all special fittings (regulating valves, etc.) in piping systems.
 - At every access door.
- D. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1. The following standardized color code scheme shall be used:
- Yellow - Hazardous Materials
 Green - Liquid Materials of Inherently Low Hazard
 Blue - Gaseous Materials of Inherently Low Hazard
 Red - Fire Protection Materials
- E. The size of letter and length of color field shall conform to the ANSI standard and shall be as follows:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
1/2" to 1.25"	8"	1/2"
1.5" to 2"	8"	3/4"
2.5" to 6"	12"	1.25"
8" to 10"	24"	2.5"

Over 10"

32"

3.5"

- F. All pipe labels shall be semi-rigid plastic identification markers. Each label shall have appropriately color-coded background with printed legend. Directional flow arrows shall be included on label. Labels shall "Snap-On" around pipe without the requirement for adhesive or bonding of piping sizes 3/4" through 5". Labels for piping 6" and larger shall be furnished with spring attachment at each end of label. Labels shall be "SETMARK" Type SNA, 3/4" through 5" size and Type STR, 6" and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.
- G. Attach pipe markers to lower quarter of the pipe on horizontal runs and on the centerline of vertical piping where view is not obstructed. Flow indicator arrow shall point away from pipe marker.
- H. Provide the following labels, with ANSI/OSHA color for all piping systems as shown on the drawings and as listed below:

Service/Legend	Letter Color	Background Color
Domestic Cold Water	White	Green
Domestic Hot Water	Black	Yellow
Domestic Hot Water Return	Black	Yellow
Sanitary Sewer	White	Green

2.7 IDENTIFICATION OF CONTROL SYSTEM DEVICES

- A. All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the contract drawings.

2.8 EQUIPMENT TAGS

- A. Furnish and install equipment identification tags for all items of PLUMBING equipment furnished and installed under Division 22. Equipment tags shall be a minimum of 3/32" thick laminated phenolic plastic.

2.9 ACCESS DOORS

- A. Provide all access doors required for access to valves, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work shall be borne by the Contractor. The type of access door shall be as required by the room finish schedule. Acoustical tile access doors shall be equal to Milcor Model CF, Model K for acoustical plaster, Model M for sidewall drywall or plaster construction.
- B. Access doors shall be not less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

- C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be a fire rated access door with U.L. label, as manufactured by Milcor or equivalent. Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

- A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the plumbing work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

- A. The plumbing drawings show the general arrangement of all piping, fixtures, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents, including but not limited to Division 21 Fire Suppression, Division 23 HVAC, Division 26 Electrical, and Division 28 shall be considered as part of the work insofar as this information furnishes the Contractor with details relating to design and construction of the building. Architectural and Structural drawings shall take precedence over the plumbing, HVAC, and fire suppression drawings. Because of the small scale of the plumbing, HVAC, and fire suppression drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work, accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. Should conditions necessitate a rearrangement of piping, such departures and the reasons therefore shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No such changes shall be made without the prior written approval. All changes shall be marked on the set of record drawings by the Contractor.
- B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.
- C. Installation of all plumbing equipment and piping systems shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Piping systems shall not be routed through, or above electrical equipment room or electrical equipment space designed within equipment rooms.
- D. The installation of all concealed plumbing systems shall be carefully arranged to fit within the available space without interference with adjacent structural and electrical systems. The Contractor shall make all necessary provisions for penetrations of piping, including sleeves and blockouts in structural systems. The exact location of all exposed plumbing systems; access doors; piping exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it specifically relates to the architectural

aesthetic design requirements for the facility.

3.3 FIELD MEASUREMENTS

- A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for perfect efficiency, and shall report any work which must be corrected. Coordination of all plumbing work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the plumbing work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor with all building trades. Each contractor shall so harmonize his work with that of the several other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipelines which require a stated grade for proper operation. Sewer lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Installation of plumbing, HVAC and fire suppression equipment within the ceiling cavity shall be in the following order of priority: plumbing waste lines; roof drains; supply, condensate piping; ductwork; fire sprinkler mains; fire sprinkler branch piping and sprinkler runouts; heating hot water and chilled water piping; domestic hot and cold water; control piping, wiring and conduit; miscellaneous special piping systems.

3.4 EQUIPMENT SUPPORT

- A. Contractor shall provide support for equipment to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork, and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.5 PROTECTION OF MATERIALS AND EQUIPMENT

- A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.
- B. Plumbing equipment and materials, including piping, valves and fittings, etc., shall be protected from damage and contamination. Equipment and materials shall not be stored outside and exposed to weather and ambient conditions without appropriate protection measures. Equipment and materials shall be delivered to the jobsite and maintained while on the jobsite with all openings, controls and control panels covered with caps, with heavy duty polyethylene wrap or other proper means. Equipment and materials where stored within the building shall be protected at all times from construction damage and contamination from dust, dirt, debris, and especially during fireproofing, painting and gypboard sanding and finishing. Unprotected equipment and piping will require special field cleaning by the Contractor prior to acceptance by the Owner's Representative.

- C. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Owner's Representative prior to such storage.
- D. Pipe openings shall be closed with caps or plugs or covered to prevent lodgement of dirt or trash during the course of installation. At the completion of the plumbing work, fixtures and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Owner's Representative.

3.6 TRENCHING AND BACKFILLING

- A. All excavation, trenching and backfilling required for the plumbing installation shall be provided by this Contractor.

3.7 MANUFACTURER'S INSTRUCTIONS

- A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Engineer and Owner's Representative, who shall make such compromises as he deems necessary and desirable.

3.8 ALIGNMENT OF FLEXIBLE COUPLINGS

- A. Flexible couplings between motors and driven equipment shall be aligned by the qualified service technician after the equipment is installed and ready for operation. Proper aligning shall be provided within manufacturer's maximum alignment tolerance at equipment operating conditions and temperature. Alignment shall follow unit manufacturer's written procedures using approved dial indication methods for parallel and angular alignment. The Contractor shall provide written certification that each device has been so aligned.

3.9 PRESSURE RELIEF DEVICES

- A. Pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with Code requirements.

3.10 TESTS

- A. Tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect, Engineer, and Owner's Representative a minimum of one week in advance of scheduled tests. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.11 INSTALLATION CHECK

- A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

- B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and (4) has been operated under full load conditions and that it has operated satisfactorily.
- C. Equipment requiring installation check includes the following:
 - 1. Mixing Valves at Plumbing Fixtures
 - 2. Domestic Hot Water Heaters

3.12 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall furnish complete operating and maintenance instructions covering all units of plumbing equipment fixtures, faucets, etc., herein specified together with parts lists. Equipment spare parts shall include all components requiring service.
- B. Operating and maintenance manuals as required herein shall be submitted for review and distribution to the Owner not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.
- C. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the plumbing systems and equipment for a period of five (5) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative fully in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks' notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.
- D. The Contractor shall video the instruction and training sessions and, at the completion and acceptance (by Owner and Architect) of the training sessions, the Contractor shall submit an electronic copy of the video.
- E. Operational test shall be conducted by the Contractor with the assistance of the equipment manufacturer's representative or service technician. Test shall be conducted in the presence of the designated and authorized Owner's Representative.

3.13 CERTIFICATIONS

- A. Before receiving final payment, the Contractor shall certify in writing that all equipment furnished, and all work done is in compliance with the contract documents and all applicable codes. Submit certifications and acceptance certificates, including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.14 CONSTRUCTION PHASING AND SCHEDULE

- A. All work furnished and installed under Division 22 of this Specification shall be provided in accordance with the project schedule and phase requirements.

3.15 OPERATION PRIOR TO ACCEPTANCE

- A. Operation of equipment and systems installed by the Division 22 Contractor for the benefit

of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

- B. Operation of equipment and systems installed by the Division 22 Contractor, for the benefit of the Contractor, except for the purposes of testing and balancing will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.16 SITE VISITS AND OBSERVATION OF CONSTRUCTION

- A. The design professional shall make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities. The design team has no authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.
- B. Prior to the "Final" observation visit, the attached "Final Observation Checklist" shall be completed by the Contractor. Any non-applicable items shall be marked "N/A." The completed form shall be submitted, indicating that all necessary items are complete and requesting a final observation within 10 days. The Contractor shall be notified of any uncompleted items within seven (7) days. A resubmittal of the form and a new final observation request by the Contractor is required if the form is returned and noted as incomplete.

END OF SECTION

Project: _____ Date Submitted _____
General Contractor: _____ Date of Final Mechanical System: _____
Mechanical Contractor: _____ Observation Requested: _____

CONTRACTOR'S MECHANICAL & PLUMBING CHECK LIST
(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

PIPING

- _____ 1. All plumbing fixtures are set, sealed and cleaned.
- _____ 2. All domestic pipe systems are insulated.
- _____ 3. All pipe systems are identified with specified labels and directional arrows.
- _____ 4. Floor sinks and drain grates are cleaned and debris removed.
- _____ 5. Valve tags are installed.
- _____ 6. Special equipment (water softeners, water heaters, piping systems, etc.) have been checked and put into service.
- _____ 7. Lab gas systems have been checked and certified.
- _____ 8. Special piping systems have been cleaned and pressure tested.
 - _____ Process Piping (RO Water)
 - _____ Compressed Lab Air
 - _____ Natural Gas
- _____ 9. Limestone chips have been installed in acid dilution sumps.
- _____ 10. Plumbing/piping connections have been completed to Owner furnished equipment and equipment furnished by other Contractors/Sub-Contractors.
- _____ 11. Exterior wall hydrants have been cleaned.
- _____ 12. Concrete collars have been installed at clean-out to grade, valve box, or other specified plumbing items.
- _____ 13. Drains and relief lines from plumbing equipment have been installed and secured in a proper manner.
- _____ 14. All plumbing equipment and areas of equipment have been cleaned and debris removed.
- _____ 15. All plumbing equipment required by the Specifications has been identified and/or numbered.
- _____ 16. Domestic water systems flush have been completed.

- _____ 17. Strainers/suction diffusers have been cleaned (Including flush valves)
- _____ 18. Backflow preventers have been teste and certified.
- _____ 19. Air has been vented from all systems.
- _____ 20. Water systems have been cleaned (X) and pressure tested (P).
- | | | | |
|-------|-----------------------|-------|---------------------|
| _____ | RO Water System | _____ | Domestic Hot Water |
| _____ | Domestic Cold Water | _____ | Acid Waste and Vent |
| _____ | Sanitary Sewer & Vent | _____ | Other (list) |
- _____ 21. PRV's have been adjusted (water, gasses).

PLUMBING EQUIPMENT

- _____ 1. All pump shafts and couplings have been aligned.
- _____ 2. Domestic water heaters have been started and tested.
- _____ 3. All plumbing equipment has been lubricated.
- _____ 4. Plumbing equipment has been labeled in accordance with the specifications.
- _____ 5. "HAZARDOUS AREA" signs installed where applicable.
- _____ 6. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.

GENERAL ITEMS

The following specified items have been submitted:

- _____ 1. Record drawings (to be submitted prior to final payment to the Contractor).
- _____ 2. Operation and maintenance manuals.
- _____ 3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 22 0500).
- _____ 4. Test kits furnished to Owner.
- | | |
|-------|------------------------|
| _____ | Flow Measuring Devices |
| _____ | Flow Balance Valves |
| _____ | Flow Control Devices |
- _____ 5. Control schematics and sequence of operation.
- _____ 6. Plumbing equipment and lubrication, valve, charts have been provided to Owner's Representative.

END CHECKLIST

DIVISION 22 SUBSTITUTION REQUEST FORM (SRF)

TO: RAMIREZ SIMON ENGINEERING, LLC
PROJECT: ESOC DATA CENTER COOLING UPGRADES

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐

If YES, explain: _____

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐

3. List differences between proposed substitutions and specified item.

Specified Item

Proposed Substitution

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐

5. What affect does substitution have on other trades? _____

6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐

If YES, explain: _____

7. Will substitution affect progress schedule? YES ☐ NO ☐

If YES, explain: _____

8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐

If YES, explain: _____

SUBMITTED BY: Firm: _____ Date: _____

Address: _____

Signature: _____ Telephone: _____

For Engineer's Use Only

Accepted _____ Not Accepted: _____ Received too Late: _____

By: _____ Date: _____

Remarks: _____

BIM/CAD AGREEMENT

PROJECT: ESOC DATA CENTER COOLING UPGRADES

Contractor understands and acknowledges by signature below that by transferring BIM/CAD documents for contractor/subcontractor use, Ramirez Simon Engineering, LLC (RSE) disclaims all warranties and obligations or liabilities for damages, including, but not limited to, consequential damages arising from or in connection with the use or performance of the documents. Contractor shall use documents at contractor's sole risk and without liability, risk, or legal exposure to RSE. Documents are diagrammatic in nature developed to display the general scope of the project. It is the contractor's responsibility to verify dimensional requirements.

Contractor agrees to limit document distribution and use to only contractor employees or subcontractors on this project. Contractor shall not distribute documents to any other entities without written consent from RSE.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2: _____

Date: _____

SECTION 22 0504
PIPE AND PIPE FITTINGS FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.
- B. Lead Ban: All piping, solder and flux used in the installation of piping systems furnished and installed under Division 22, shall be lead free. The term lead free is defined as pipe which does not contain more than 0.25% lead and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

- A. See Section 22 0500 for Common Work Requirements for Plumbing.

1.3 SUBMITTAL DATA

- A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

See Division 23, Section 23 05 04 for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 05 04 for applicable requirements.

END OF SECTION 22 0504

SECTION 22 0505
PIPING SPECIALTIES FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.

1.2 RELATED SECTIONS

- A. See Section 22 0500, for Common Work Requirements for Plumbing.
- B. See Section 22 0504, for Pipe and Pipe Fittings for Plumbing.
- C. See Section 22 0523, for Valves for Plumbing.
- D. See Section 22 0700, for Plumbing Insulation.
- E. See Section 22 1100 Facility Water Distribution.

1.3 SUBMITTAL DATA

- A. The Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications, and approvals of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

See Division 23, Section 23 05 05, Piping Specialties.

PART 3 - EXECUTION

See Division 23, Section 23 05 05, Piping Specialties.

END OF SECTION 22 0505

SECTION 22 0523
VALVES FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. All Valves shall conform with current applicable provisions of the General Conditions, Supplementary Conditions, and General Requirements.
- B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.
- C. Lead Ban: Valves shall be lead free.

1.2 RELATED SECTIONS

- A. Section 22 05 00 for Common Work Requirements for Plumbing.
- B. Section 22 05 00 for Valve Identification.
- C. Section 22 05 04 for Pipe and Pipe Fittings.
- D. See Division 23 for Valves.

1.3 SCOPE

- A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

- A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Grinnell, or equivalent.
- B. All lubricated plug valves shall be as manufactured by Walworth, Homestead, or equivalent.
- C. Ball valves shall be utilized in lieu of gate valves and globe valves for all plumbing systems for sizes 2" and smaller.
- D. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.
- E. Provide chain operators for valves 4" and larger installed within mechanical equipment spaces where valves center line is in excess of eight feet above the floor or operating platform.

PART 2 - PRODUCTS

See Division 23, Section 23 05 23 for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 05 23 for applicable requirements.

END OF SECTION 22 0523

SECTION 22 0700
PLUMBING INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.
- B. Materials shall conform to applicable ASTM standards.

1.2 RELATED SECTIONS

- A. See Section 22 05 00, for Common Work Requirements for Plumbing.
- B. See Section 22 05 04, for Pipe and Pipe Fittings.

1.3 SCOPE

- A. Domestic hot water pipe including soft hot water and circulating hot water, interior roof drains including roof drain bowls, interior overflow roof drains including overflow roof drain bowls, domestic cold water and soft cold-water piping, and water piping located outdoors exposed to ambient freezing conditions.
- B. Equipment covering, including storage tanks, pumps, and domestic hot water heater stacks and breeching.

1.4 FITTINGS

- A. All fittings except as otherwise specified, shall be insulated with the same material and thickness as specified for the pipe.
- B. Unions, flanges and valves on hot water, will not require insulation.

1.5 TESTING

- A. All piping shall be tested in accordance with the applicable Specification Sections, before any insulation is applied.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Insulation shall be as manufactured by Armacell, Owens-Corning Fiberglas, Knauf, Johns Manville, or Armstrong, or equivalent, and shall be equal to that specified below. Insulation and all materials on the interior and exterior surfaces of ducts, pipes, and equipment shall have a composite fire and smoke hazard rating not exceeding: Flame spread - 25; fuel contribution - 50; smoke developed - 50, as determined in accordance with ASTM Standard E-84. All insulation materials used for valves and fittings shall have the same ratings as the pipe insulation. Information must be submitted by means of manufacturer's literature showing that the proposed materials conform to above specification without exception.

- B. Type P-1, Fiberglass Pipe Insulation: Factory assembled insulation and ASJ. Pre-formed fiberglass per ASTM C547 Type I, suitable for use on surfaces from 0–850°F, with thermal conductivity 0.27 at 75°F or 0.33 at 250°F, and minimum 3 pcf density. Jacket shall be all service (ASJ) vapor barrier jacket with white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self-sealing longitudinal laps and butt strips. Owens Corning SSL II Pipe Insulation, Johns Manville Micro-Lok, Knauf Pipe Insulation. Johns Manville 'Micro-Lok' or equivalent. Where Type P-1 insulation is used, insulate fittings, valves and accessories using Fiberglass pre-formed fitting insulation complying with the specification for P-1 pipe insulation, Johns Manville Hi-Lo Temp insulation inserts, Hamfab, OAE. Finish with PVC Jacketing fitting covers.
- C. Type P-2 Elastomeric Foam Insulation: Pre-formed elastomeric foam, ASTM C534 Type 1 flexible, closed cell, suitable for use up to 220°F, UV protected, not to exceed flame spread 25 and smoke developed 50 based on 0.75-inch thickness, conductivity 0.30 at 75°F. Connections shall be made using manufacturer's approved waterproof vapor barrier retarder adhesive. Provide outdoor U.V. protective coating on all insulation exposed to ambient conditions. Armacell OAE. Where Type P-2 insulation is used, insulate fittings, valves and accessories using pre-formed insulation for use on fittings and valves.
- D. P-3: Fiberglass preformed board insulation for equipment shall conform to ASTM C612 with 'K' factor of 0.23 at 75°F, R=8.0 minimum, 3.0 pound per cubic foot density. Provide vapor barrier jacket (FSK) with aluminum foil reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and outward clinched expanded staples and vapor barrier mastic. Johns Manville 'Spin-Glas' or equivalent.
- E. P-4: Elastomeric foam insulation for piping and equipment shall be flexible, cellular, molded or sheet, conforming to ASTM C534, with 'K' factor of 0.28 at 75°F., maximum service temperature of 220°F., maximum flame spread rating of 25 and maximum smoke development rating of 50 (3/4" thickness and less). Connections shall be made using manufacturer's approved waterproof vapor barrier retarder adhesive. Provide outdoor U.V. protective coating on all insulation exposed to ambient conditions.

2.2 FITTINGS

- A. Valves and fittings, where required to be insulated, shall be covered with the same insulation material and thickness as specified for the pipe insulation and finished with PVC covers.
- B. Valves and fittings with systems specified to be covered with metal or canvas, or polyvinyl chloride (PVC) jacket shall be covered with material to match piping system jacketing.
- C. Polyvinyl chloride (PVC) preformed fitting covers with fiberglass inserts shall be used on valves and fittings, except where metal or canvas jacket is required for piping system. PVC fitting covers shall be Zeston 2000 or equivalent, gloss white and shall have a composite fire and smoke hazard rating not exceeding; flame spread - 25; smoke development - 50. Connections shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

2.3 METAL JACKETING

- A. Type J-1 Stainless Steel Jacket: Metal jacket shall be 0.010-inch smooth Type 304 stainless steel. Provide moisture barrier lining for service temperatures 60°F and less, except where applied over insulation with All Service (ASJ) vapor barrier jacket. Stainless steel jacket shall be installed where specified herein or otherwise indicated on the drawings.

2.4 PVC JACKETING

- A. Type J-2 PVC Jacket: PVC jacketing shall be Zeston 2000/300 or equivalent, gloss white, 0.020-inch thickness, minimum, and shall have a composite fire and smoke hazard rating not exceeding; flame spread -25; smoke development -50. Connection shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings. Solvent Cement for PVC Jackets shall be Johns Manville Perma-Weld OAE.

2.5 PIPE HANGERS AND SUPPORTS

- A. See Specification Section 22 0504 for requirements associated with hangers and supports for piping systems.
- B. All insulated piping systems shall be provided with individual hangers sized to encircle the insulation.
- C. Pipe Hanger Insulation Inserts: Mechanical Pipe Shields Inc. "Snapp Itz" OAE.
- D. Insulated piping supported by means of trapeze hangers or roller type hangers shall not rest directly on the hanger or support.
- E. The insulation at hangers, trapezes and supports shall be protected by means of galvanized steel insulation half diameter support shields. Provide insulation insert between support shield and piping for piping size 1-1/2" and larger. Insulation inserts shall be heavy density calcium silicate molded insulation. Insulation inserts shall be the following minimum lengths. Factory fabricated thermal pipe shield as manufactured by Pipe Shields, Inc., and specified in Section 22 0504, may be used at Contractor's option.

<u>Pipe Size, In.</u>	<u>Insert Length</u>
1-1/2" to 2-1/2"	10" Long
3" to 6"	12" Long
8" to 10"	16" Long
12" and larger	22" Long

2.6 PIPE SLEEVES

- A. See Specification Section 22 0504 for requirements associated with pipe sleeves for piping penetrations for building walls and frames.
- B. Pipe sleeves shall be provided at penetrations through concrete and masonry construction and at fire rated and smoke rated walls and penetrations when required to comply with UL approved penetration assembly. Insulated piping passing through fire walls and smoke walls shall be provided with UL approved fire safing insulation to match the required insulation thickness and the space between the piping penetration and the adjacent wall construction shall

be sealed airtight with UL approved fireproof caulking material. Pipe penetration arrangement and installation requirements shall match the applicable UL approved penetration assembly details.

PART 3 - EXECUTION

- A. General: Insulate piping as indicated herein and on the drawings. Except as noted, insulate all valves, fittings, and accessories with the same material and thickness specified for the pipe. Where piping is specified with a separate insulation jacket provide this same jacket for valves, fittings, and accessories. Vapor seal cold piping systems.
- Where insulation terminates, provide insulating cement beveled for a neat finish. For vapor sealed piping, coat with insulating mastic prior to applying insulating cement.
 - Strainers and Suction Diffusers: Type P-1. Make provisions to easily remove and re-install insulation.
 - Pipe Supports: Provide high density calcium silicate insulation or insulation inserts as specified. Maintain pipe jacket and vapor barrier at supports. If necessary, apply a heavy coating of vapor barrier mastic material to prevent condensation from forming on supports. Provide galvanized steel insulation shields to protect insulation and jackets at supports.
 - Penetrations Through Building Construction: Insulation shall be continuous where piping passes through walls, floors, and other construction. Where insulated piping passes through fire and/or smoke rated construction, provide a section of UL approved fire safing insulation to match the required insulation thickness, or provide an insulated pipe sleeve as manufactured by Pipe Shield, Inc., OAE.
 - Mechanical Couplings: Where mechanical couplings are permitted, insulate them as specified for fittings.
 - All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.
 - The termination of all insulation on pipes, at uninsulated valve connections, or unions, flexible connections, etc., shall be beveled and finished.

B. Application:

Temp Range	Temp (F)	Insulation Type	Vapor Sealed	Pipe Size (inch dia.)				
				Under 1	1 & 1.25	1.5 - 3	4 & 6	8 & Larger
				Insulation Thickness (inches)				
TR-1	60&Less	P-2	Yes	1.0	1.0	1.5	1.5	2.0
TR-2	61 - 104	P-2	Yes	1.0	1.0	1.0	1.0	1.0
TR-3	105 - 140	P-2	No	1.0	1.0	1.5	1.5	2.0
TR-4	141 - 200	P-2	No	1.5	1.5	2.0	2.0	2.0

- Temperature Range TR-1: Sanitary/Waste Floor drains/sinks indoors and associated piping as well as storm drain piping.
- Temperature Range TR-2: Domestic cold water.
- Temperature Range TR-3: Domestic hot water.
- Temperature Range TR-4: Domestic hot water.

- C. Type P-1, Fiberglass Insulation: Install in accordance with manufacturer's recommendations.

- D. Type P-2, Elastomeric Foam: Seal all butt ends and longitudinal joints with Halstead

Adhesive. When exposed to the weather, protect flexible tubing insulation with two coats of exterior weatherproof coating as recommended by manufacturer.

E. Jacketing:

1. Type J-1 jacketing shall be applied with joints overlapped 2" and located to shed water. Joints and seams shall be caulked with an approved weatherproof caulking when located outdoors. The insulation shall be banded 12" on centers or screwed in place 3" on centers. Fittings and valves shall have insulation covered with metal jacket, as specified herein. Fittings and valves on exterior piping shall be covered with metal jacketing to match pipe.
2. Type J-2 shall be secured in place in an approved manner by means of tacks and pressure sensitive tape. Fittings and valves shall have insulation covered with PVC pre-molded PVC fittings to match jacketing. PVC jacketing shall not be permitted for use on
3. In addition to the finish and jacket specified for the particular type of insulation, provide the following:
 - a. Indoor piping exposed to physical damage or visible to general occupants Type J-1, Metal
 - b. Mechanical Equipment Spaces: Exposed piping less than 8 ft above floor or operator platform Type J-1, Metal
 - c. Exterior piping Type J-1, Metal

3.2 PIPING INSULATION

- A. General: Insulate piping as indicated herein and on the drawings. Except as noted, insulate all valves, fittings, and accessories with the same material and thickness specified for the pipe. Where piping is specified with a separate insulation jacket provide this same jacket for valves, fittings and accessories. Vapor seal cold piping systems.

1. Where insulation terminates, provide insulating cement beveled for a neat finish. For vapor sealed piping, coat with insulating mastic prior to applying insulating cement.
2. Strainers and Suction Diffusers: Type P-1. Make provisions to easily remove and re-install insulation.
3. Pipe Supports: Provide high density calcium silicate insulation or insulation inserts as specified. Maintain pipe jacket and vapor barrier at supports. If necessary, apply a heavy coating of vapor barrier mastic material to prevent condensation from forming on supports. Provide galvanized steel insulation shields to protect insulation and jackets at supports.
4. Penetrations through Building Construction: Insulation shall be continuous where piping passes through walls, floors, and other construction. Where insulated piping passes through fire and/or smoke rated construction, provide a section of UL approved fire safing insulation to match the required insulation thickness, or provide an insulated pipe sleeve as manufactured by Pipe Shield, Inc., OAE.
5. Mechanical Couplings: Where mechanical couplings are permitted, insulate them as specified for fittings.
6. All voids formed by support saddles or other mounting, or support hardware shall be filled with insulation.

B. Special Applications

1. Heat Traced Piping: Oversize insulation as required to accommodate heat tracing. Provide metal jacket.
2. Plastic pipe in return air plenums: Provide 0.5-inch type D6 insulation.
3. Piping subject to freezing and heat traced piping: Insulate all such piping (including drain piping) with thicknesses specified, but not less than 2-inch thickness. Oversize insulation to accommodate heat tracing where applicable. Provide metal jacket.

3.3 DOMESTIC COLD WATER AND SANITARY SEWER RECEIVING CONDENSATE WATER FROM HVAC SYSTEMS

- A. Domestic cold-water piping, non-potable water piping, indoor sanitary sewer receiving condensate water from HVAC equipment, and indoor storm water piping shall be insulated with 1-inch thick (P-4) elastomeric foam insulation. Fittings shall be finished with PVC fitting covers.

3.4 METAL JACKETING

- A. Metal jacketing shall be installed on all field insulated plumbing equipment and on plumbing piping systems exposed within the mechanical equipment spaces, that are installed exposed below 8 feet above the floor, where exposed to physical damage, on outdoor insulated piping, and where noted on the drawings.
- B. The jacketing shall be applied with joints overlapped 2" and located to shed water. Joints and seams shall be caulked with an approved weatherproof caulking when located outdoors. The insulation shall be banded 12" on centers or screwed in place 3" on centers.
- C. Fittings and valves shall have insulation covered with metal jacket, as specified herein. Fittings and valves on exterior piping and ductwork shall be covered with metal jacketing to match pipe and duct covers.

3.5 TERMINATION OF INSULATION

- A. The termination of all insulation on pipes, at uninsulated valve connections, or unions, flexible connections, etc., shall be beveled and finished.

END OF SECTION 22 0700

SECTION 22 1100
FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with the applicable provisions of the General Conditions, Supplementary Conditions, and the General Requirements.
- B. Lead Ban: All piping, solder, and flux used in the installation of piping systems delivering water for human consumption shall be lead free. The term lead free is defined as pipe which does not contain more than 0.25% lead, and solder and flux which does not contain more than 0.2% lead. Solder shall be 95/5 tin antimony, alloy Sb5, conforming to FS QQ-S-571.

1.2 RELATED SECTIONS

- A. See Section 22 0500, for Common Work Requirements for Plumbing
- B. See Section 22 0504, for Pipe and Pipe Fittings for Plumbing.
- C. See Section 22 0505, for Piping Specialties for Plumbing.
- D. See Section 22 0523, for Valves for Plumbing.
- E. See Section 22 0700, for Plumbing Insulation.

1.3 SCOPE

- A. Renovation including modifications to domestic cold water, hot water, recirculating hot water, backflow protection, shock absorbers, and associated miscellaneous accessories. This section shall include all work required to accommodate the renovation.

PART 2 - PRODUCTS

2.1 PIPING

- A. Domestic water piping, above grade within the building 3" and smaller shall be Type L hard drawn copper, ASTM B88. Domestic water piping including soft water piping larger than 4" shall be copper as specified herein.
- B. Proper insulating fittings, as specified in Section 22 0504, shall be installed to prevent electrolytic action between steel and copper piping connections.

2.2 FITTINGS

- A. Fittings for copper piping shall be wrought copper or cast brass conforming to ANSI B16.22 and B16.23, with 95-5 solder joints, as specified in Section 22 0504.
- B. Mechanically formed tee connections and couplings for copper piping system as specified in Section 22 05 04, may be utilized where approved.
- C. Fittings for galvanized steel pipe shall be screwed Class 150, standard galvanized malleable iron conforming to ANSI B16.3

- D. Fittings for ductile iron pipe shall be flanged or mechanical joint conforming to ANSI/AWWA C110 and C111, Class 250 minimum, cement lined, with bituminous coating.

2.3 FLANGES

- A. Flanges for copper piping systems shall be Class 150 wrought copper or cast brass conforming to ANSI B16.24.
- B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.
- C. Flanges for galvanized steel piping system shall be galvanized cast or malleable iron Class 125, standard threaded plain face companion flanges for flanged connections in threaded piping systems.
- D. Gaskets shall be 1/16" thick ring type or full face non-asbestos material suitable for the temperatures and pressure application.
- E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

2.4 JOINTS

- A. Joints in copper piping system shall be made using approved "lead-free" solder and flux as described herein and approved by all applicable codes and regulations. Surfaces to be soldered shall be cleaned bright by manual or mechanical means.
- B. All joints shall be properly fluxed with a non-corrosive "lead-free" type flux manufactured to approved standards, Federal Specification QQ-S-517. Joints for copper piping systems for cold water 3" and smaller and hot water 2" and smaller shall be made using composition 95-5 tin-antimony solder. Composition 15% silver solder shall be used for all other piping sizes and for all underground joints.

2.5 SHOCK ABSORBERS

- A. Furnish and install factory sealed shock absorbers conforming to Federal Specification WW-P-541 at locations shown on the drawings and/or as outlined by Plumbing Drainage Institute Standard WH-201. Josam, Precision, Jay R. Smith, Wade, Watts, Zurn or equivalent.

2.6 VALVES

- A. Valves other than automatic control valves are specified in Section 22 0523, Valves.
- B. Automatic control valves shall be as specified in Section 25 0000, Integrated Automation, except for automatic control valves furnished as a part of equipment packages, including hot water generating equipment, as specified on the equipment schedule.

2.7 BACKFLOW PROTECTION

- A. All cross-contamination control shall be provided to ensure that no installation of the potable water supply piping system shall be made in a manner that will allow used, unclean, polluted, or contaminated water or substances to enter the domestic potable water system.

- B. All backflow devices and assemblies shall be approved by the applicable Administration Authorities and shall be installed according to all applicable codes, regulations, and manufacturer's instructions. Installation shall allow for required access and clearance for required testing, maintenance, and repair.
- C. Reduced pressure backflow preventer assembly shall be furnished and installed by the Contractor. Backflow preventer size and arrangement shall be as indicated on the drawings, and shall be as manufactured by Watts, or equivalent. All costs, fees, and permits required shall be secured and paid for by the Contractor, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for plumbing.
- B. Insulating Fittings: Insulating unions shall be furnished and installed at all connections between dissimilar metals.
- C. Valves: Each water service main, branch main and branch to a group of two or more fixtures shall be valved. Stop valves shall be as specified under fixtures.
- D. Flexible Connections: If the Contractor uses a pipe material other than copper to connect to the city water main, provide mechanical joints at the connection point and also either a swing joint or expansion joint at a point 5 ft. outside the building to prevent failure of piping caused by differential settling of building and piping systems. The expansion joint material shall be suitable for domestic water usage and compatible with the sterilization chemicals.
- E. Testing: Arrange for testing backflow devices as required by the local health authorities.

3.2 TESTS

- A. All water piping, hot and cold, shall be made tight under a hydrostatic test pressure of 150 lbs. per square inch and maintained without pressure loss for a minimum of four (4) hours. No caulking of joints will be permitted. Any joint found to leak under this test shall be broken, remade and a new test applied.

3.3 STERILIZATION

- A. All new water piping shall be charged with a chlorine solution containing not less than 50 PPM available chlorine. The solution shall remain in the piping for a period of 24 hours, during which time valves shall be opened and closed to permit a small flow of the solution. At the end of 24 hours, the solution shall be tested and must contain a residual of at least 5-10 PPM chlorine. The system shall then be drained and flushed to provide satisfactory potable water before final connection is made to the existing distribution system.
- B. The Contractor shall submit a sample of the water, after sterilization and flushing for testing by an approved laboratory. A copy of the acceptable test report shall be submitted to the Owner's Representative prior to substantial completion.

3.4 BACKFLOW PROTECTION

- A. Protection: All plumbing fixtures, faucets with hose connections, and all other equipment having plumbing connections shall have their water supplies protected against back-siphonage. Refer to drawings for backflow preventers to be used for different applications.
- B. Testing: Arrange for testing backflow devices as required by the local health authorities.

END OF SECTION 22 1100

SECTION 23 0500
COMMON WORK REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. See General Conditions and Supplemental General Conditions.
- B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this Section and all subsequent sections of this Division and form a part of the contract.

1.2 DEFINITIONS

- A. General: Terms will have meanings as defined in Webster's Eleventh New Collegiate Dictionary except as noted below.
- B. Entities
 - 1. Owner: Williamson County
 - 2. Engineer: Ramirez Simon Engineering, LLC
 - 3. Owner's Agents: The Architect, Engineers, and others authorized to act on behalf of the Owner.
- C. Actions
 - 1. Supply: Procure and deliver to the site with all features as specified, required per code, and standards, and as required for proper installation. Include submittals, O&M manuals, operator instructions, and warranty.
 - 2. Install: Set in place in accordance with manufacturer's instructions, contract documents, and applicable codes and standards. Coordinate the installation with other disciplines, start, and demonstrate proper operation.
 - 3. Furnish: Supply and install.
 - 4. Provide: Supply and install.
- D. Locations
 - 1. Buried: Surrounded by soil or other material, either beneath the building or exterior to the building.
 - 2. Exterior: Exposed to rain or snow. Examples include rooftop locations, spaces around cooling towers, pipe racks, etc.
 - 3. Interior: Not exterior or buried. Examples include not only spaces within the heated envelope of the building, but also unheated attics, covered loading docks in which spaces are protected from rain and snow, utility tunnels, sheds, etc.
 - 4. Finished Spaces: Interior spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated attics, spaces above ceilings, crawlspaces, and tunnels.
 - 5. Exposed: Exposed to view. Examples include finished spaces mechanical equipment rooms, rooftops, etc.
 - 6. Concealed: Not Exposed.

Other Definitions:

1. 24/7: 24 Hr./day, 7 days per week, year-round.
2. AHJ: Authorities having jurisdiction. The authorities having jurisdiction over this project are established by statute, and include governmentally designated building departments, the fire marshal, fire departments, etc. No attempt is made to list all such entities here; a qualified Contractor is expected to know and coordinate with the various authorities having jurisdiction.
3. FMS: Facility Management System and referred as BAS (Building Automation System)
4. OAE: Or approved equal.

1.3 CODES AND PERMITS

- A. Perform all work in accordance with the Williamson County Standards, 2018 International Building Code, the 2018 International Plumbing Code, and the 2018 International Mechanical Code, as adopted and interpreted by the State of Texas, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations, and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. Contractor shall hold and save the Owner and his agents free and harmless from liability of any nature or kind arising from the Contractor's failure to comply with codes and ordinances.
- B. Secure and pay for all permits necessary for performance of the work, including utility connections, extensions, meter pits and meter sets and tap fees for water, storm sewer, sanitary sewer and natural gas, unless otherwise specified herein.
- C. Comply with the requirements of, and the recommendations of:
 1. Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances
 2. National Electrical Manufacturer's Association
 3. National Electrical Code
 4. Underwriters Laboratories
 5. American National Standards Institute
 6. American Society for Testing Materials
 7. Local utility companies
 8. National Fire Protection Association
 9. ASME Boiler and Pressure Vessel Codes
 10. Occupational Safety and Health Administration
 11. International Mechanical, Plumbing, Codes
 12. International Fire Code
 13. Midwest Insulation Contractors' Association (MICA)
 14. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 15. American Society of Sanitary Engineering
 16. American Gas Association

1.4 DOCUMENT MANAGEMENT

- A. Contractor is encouraged to use a web-based document management system for RFIs and submittals. If used, Contractor shall provide and pay for licenses and training for the

engineer's project personnel. The section below describes procedures for handling submittals if a web-based document management system is not used. If a web-based system is used, the procedures below shall be modified as appropriate.

1.5 SUBMITTALS

- A. Prior to purchasing materials, equipment, and services, submit descriptive literature for review.
- B. Procedures: See individual spec sections within this division for additional submission requirements. The following describes general submittal procedures. More specific procedures will be established after award. Whenever electronic files are to be submitted, e-mail them through normal channels. But if files are too large to e-mail, then submit them in quantities as described below.
 - 1. Submittal Schedule: Along with the first item submitted for review, include a schedule listing all items to be submitted and an approximate date for each submittal. Submit this schedule in both hard copy and electronic form (Microsoft Excel). Normal review time will be 10 working days. Schedule should identify any submittals for which expedited review is requested. Update this schedule and resubmit it monthly (by e-mail) for information.
 - 2. Include the following information with each submittal:
 - a. Cover sheet identifying the project name, contractor, architect, engineer, and items included. Indicate symbol numbers, spec section, etc.
 - b. A blank space large enough to accept a review stamp.
 - c. Performance under the specified conditions
 - d. Cover sheet shall clearly identify and **HIGHLIGHT** any ways in which the submitted materials, equipment or services deviate from the Specifications.
 - 3. Quantities:
 - a. Brochures: Submit no more than seven copies plus a PDF.
 - b. Drawings: Submit one reproducible, one print, plus a PDF.
 - 4. Engineer will review one original submittal and one resubmittal for each item. If the Contractor fails to provide the required data or acceptable items with his second submittal, he will be charged for the Engineer's costs for the third and subsequent reviews.
 - 5. Required Information: Submit information to allow the Engineer to easily determine whether the submitted components comply with the general design intent. Include relevant descriptions of materials, features, performance, quality and dimensions. Cross out all features, options and accessories which will not be provided. It is assumed that all specified, indicated and/or required features will be provided unless specifically noted otherwise.

6. Where specifications require a local factory authorized service agent, submit the name, address, and contact information for this agent. Include this information also in the O&M Manual.
- C. Review of Submittals: Engineer will review submittals for general conformance with the design intent.
1. Review of a separate item as such will not indicate review of the assembly in which the item functions.
 2. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work.
 3. Review will not relieve the Contractor of responsibility to comply with the contract requirements, or responsibility to ensure that equipment fits within the allotted space with required clearances for equipment operation, service and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC).
 4. For commodity type items (plumbing fixtures, terminal units, registers, diffusers, etc.), Engineer will review submittals for type only. Contractor to coordinate sizes and quantities.
 5. Actions: Engineer will return submittals with one of the following actions:

NO EXCEPTIONS TAKEN	Contractor may proceed with the work as submitted
EXCEPTIONS AS NOTED	Contractor may proceed with the work and without resubmittal provided, he complies with all exceptions noted in the submittal, and so states in a letter
REVISE AND RESUMIT	Resubmit in accordance with the indicated comments
REJECTED	Resubmit in accordance with the contract documents

D. Substitutions:

1. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or if any work is installed in a manner which is not in conformance with the requirements of this specification and for which the Contractor has not received written authorization, removed such unauthorized work and installed work in accordance with the contract documents at no change in contract amount.

2. Authorized Substitutions: Provide all accessories and features as required and coordinate substitutions with other disciplines. Bear any extra expenses resulting from the use of substitutions which affect adjoining or related work required in this division or other divisions of the work.
 3. If the Contractor substitutes equipment for that indicated on the drawings, he shall prepare a 1/4 inch = 1 foot installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will properly fit within the space with adequate clearance for maintenance and replacement. Submit this drawing for review.
- E. Schedule: Submit all submittals in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time. Be aware that there is risk in ordering components, fabricating work, and/or installing work prior to review. If the Contractor proceeds prior to review, and then the review comments required modifications to work which has begun or has been completed, then Contractor must comply with the review comments at no change in contract amount or schedule.
- F. Shop Drawings
1. Submit shop drawings for:
 - a. Mechanical equipment rooms and other spaces housing air handling equipment, heat transfer equipment, fluid handling equipment, machinery, etc.
 - b. Complete supply, return, and exhaust ductwork systems, both exposed and concealed.
 - c. Piping for HVAC, plumbing, and fire protection systems, both exposed and concealed.
 2. Show the location and elevation of all equipment, ductwork, and piping, as well as openings through slabs and walls. Include plans, elevations, and sections as appropriate. Clearly show the manner in which the systems fit into the available space and relate to each other and to the building elements. Indicate required sleeves and openings in general construction elements. Indicate required clearances for operation, maintenance and replacement of operating devices and equipment. Drawings shall be of appropriate scale to facilitate coordination and understanding, but not smaller than 1/8-inch scale for floor plans and 1/4-inch scale for equipment rooms and chases.
 3. Conflicts: The engineer has attempted to work out conflicts in the design, but it is inevitable that conflicts will exist in the design documents. Provide experienced designers to prepare shop drawings. Exercise good design practice in working out conflicts without compromising system operation or maintenance. Coordinate with other disciplines. Identify on the shop drawings those areas where redesign was necessary to resolve design conflicts.

- a. In the event that the Contractor desires direction in resolving a design conflict or desires prior approval of a recommended approach to resolving a conflict, submit an RFI which identifies the conflict and suggests a recommended solution.
- b. In resolving conflicts, gravity lines and larger distribution mains will generally have priority over pressurized lines and smaller lines as follows:
 - 1. Plumbing waste and vent lines
 - 2. Condensate piping
 - 3. Supply, return and exhaust ductwork.
 - 4. Heating hot water and chilled water piping
 - 5. Domestic hot and cold water
 - 6. Miscellaneous special piping systems
 - 7. Use of Engineer's BIM/CAD Files: The Engineer will provide the Contractor BIM or CAD files of the design documents if the Contractor completes and submits the release form attached at the end of this spec section.

G. Submittals Required under this Specification Section:

- 1. Electrical Components: Motors, Motor Controllers, and Variable Speed Drives
- 2. Identification: Products used to identify equipment, ductwork, valves, piping, and control devices.
- 3. General Construction Components: Roof Curbs & Access doors.

1.6 DOCUMENTED COORDINATION EFFORT

- A. After shop drawings are reviewed, incorporate any review comments, and then participate in a formal and documented coordination effort with the contractors and subcontractors for other divisions of the work. Show all piping systems and equipment on the ductwork drawings and send electronic CAD files to the General Contractor and the subcontractors for plumbing, electrical, and other disciplines. The other subcontractors will then add their work to the CAD files.
- B. Make full-size plots of the drawings. Participate in meetings with the GC and other subcontractors to review each area, identify conflicts, and resolve conflicts. Submit the resolutions to the Engineer for review. Maintain adequate space for operation, maintenance, and code-required clearances. Ensure that all subcontractors initial each plan to indicate that they have participated in the coordination effort.

1.7 MISCELLANEOUS PROVISIONS

A. Qualifications

- 1. All mechanics shall be skilled in their respective trade.
- 2. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

- B. Regulated Materials: Comply with all state, local and federal regulations regarding the storage, handling or disposal of oils, lubricants, cleaning agents, refrigerants, other liquids and gases, and hazardous materials.
- C. Factory Identification: Provide all materials and equipment with labels sufficient to show compliance with these specifications and the performance requirements indicated on the drawings. All equipment shall carry a permanent label installed by the manufacturer stating that the equipment complies with the latest approved version of ASHRAE/IESNA Std. 90.1.
- D. Hazardous Conditions: Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury. In the case where asbestos or possibility of asbestos is identified, the contractor shall immediately stop work in the area and refer to the owner. Asbestos abatement would be provided under a separate contract administered by the owner.
- E. Hazard Signs
 - 1. Provide a sign reading, "Hazardous Area - Authorized Personnel Only" on the doors to all equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments.
 - 2. Provide a sign reading, "Confined Space - Entry by authorized personnel only by permit" for all confined spaces. Confined spaces shall be as designated by OSHA Standard 1910.146. This generally means a space that:
 - a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
 - b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
 - c. Is not designed for continuous employee occupancy.
 - 3. Survey the final premises to determine where any potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.8 GUARANTEE-WARRANTY

- A. Warranties shall run for one year from substantial completion unless indicated otherwise.
- B. The following warranty shall be binding:

"The Contractor warrants that this installation is free from mechanical defects. Contractor agrees to replace or repair any part of the installation which may fail within a period of one year after the date established below, provided that such failure is due to defects in materials or workmanship, or to failure to follow the specifications and drawings. This

warranty shall begin on the date set forth in the Certificate of Substantial Completion, AIA Form G704, or other such date as documented in writing by the Owner's Representative."

- C. The extent of guarantees or warranties by equipment and/or materials manufacturers will not diminish the requirements of the Contractor's warranty to the Owner.

PART 2 - PRODUCTS

2.1 PRODUCT GENERAL REQUIREMENTS

- A. General: Products supplied under Division 23 shall comply with the following except as noted elsewhere.
- B. Products shall be new; shall be the product of manufacturers regularly engaged in the production of plumbing, heating, ventilating, air conditioning, and control system equipment; and shall be the manufacturer's latest design. Specs and equipment schedules establish expectations regarding standard of quality and operating intent.
- C. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.
- D. Products shall be suitable for the conditions under which they are installed and operated. Prior to or during the submittal phase advise the Owner's representative and the Engineer in writing regarding any concerns about the suitability of the specified products for the intended application or service. Request clarification if any question exists regarding the design intent.
- E. Performance Ratings: Unless otherwise noted, all scheduled equipment performance is based on an elevation of 320 feet above sea level. Adjust manufacturer's ratings accordingly.
- F. Structural Soundness: Products shall have structural integrity appropriate to the component and its application. Bases shall be rigid and shall keep all components in proper alignment. Structural integrity shall be adequate for both rigging and final installation. Components shall not be loose, rattle, or vibrate unnecessarily in their final installed condition.
- G. Corrosion Resistance: Equipment shall be of materials inherently corrosion resistant or shall be finished with a corrosion-resistant finish suitable for the location in which the equipment is installed.
- H. Touch-up: If the factory finish of any component is damaged prior to substantial completion, touch up to original condition per manufacturer's recommendations.
- I. Equipment Access Doors or Panels: Provide access doors and panels within equipment to ensure good access to all components requiring inspection, service or maintenance. Provide appropriate hardware. Equipment installed outdoors shall be weather-tight.
- J. Fans: Statically and dynamically balanced, shaft first critical speed shall be above operating speed at design conditions.

Bearings: Grease lubricated or permanently lubricated.

- K. Couplings: Provide coupling guard.
- L. Motors and VFDs: See requirements described elsewhere in this spec section.
- M. Drive Lines (starter or VFD, motor, coupling and shaft or v-belt drive and pulleys, and driven equipment): Coordinate with all suppliers and ensure all components are compatible to work as a system.
- N. Coils: ARI rated, copper tubes mechanically expanded into aluminum fins, galvanized steel casing, drainable, pressure tested to 150% of working pressure but not less than 300 psi.
- O. Cooling Coil Drain Pans: Provide for all cooling coils, galvanized or stainless steel, double pitched with piped outlet. For units with more than one coil stacked, provide intermediate drain pans piped to the main drain pan.
- P. Filter Frames: Galvanized steel, provide wherever filters are specified.
- Q. Electrical & Controls: Except where specifically noted, electric service to each component listed on the equipment schedules will be through a single electrical feed at the voltage indicated on the equipment schedules. Include all components, cabling and conduits to distribute power to all components which are factory supplied and mounted. Provide transformer(s) if required to serve unit-mounted components requiring electric service at voltages different from the main electric service, including controls components. Provide secondary overcurrent protection. Provide terminal strips for field-installed control wiring. Provide unit-mounted, unit-specific wiring diagrams on durable paper, attached to inside of control panel door or otherwise affixed to the unit. All electrical components shall be UL Listed or Recognized. All factory-installed electrical work shall comply with the NEC unless the overall unit is listed by an organization acceptable to the AHJ and listed to a standard acceptable to the AHJ.
 - 1. Where equipment includes an LCD or other, similar display for operator interface, display all information in English. Displays should be readily understandable and should not require the user to look up display codes in a reference manual.
 - 2. Provide battery backup to retain all memory and programming, and to keep all clock-related functions powered through a 1-week power outage.
 - 3. Controls interface with the FMS:
 - a. Digital Inputs to FMS: 24V DC sourced from equipment.
 - b. Digital Outputs from FMS: Equipment to have form C relays, max 250V DC, 2 A.
 - c. Analog Inputs to FMS: 4-20 mA, 0-5V DC, or 0-10V DC sourced from equipment.
 - d. Analog Outputs from FMS: 4-20 mA sourced from FMS.

2.2 IDENTIFICATION

- A. Scope: Identify all equipment, ductwork, valves, piping, and control devices shown on the Drawings, identified in the equipment schedules, and indicated in these Specifications. Provide submittals for products and procedures used for identification.
- B. Equipment: For all mechanical equipment supplied or installed under Division 23, provide an equipment identification tag or stencil unit number onto the equipment. Stencils shall be minimum 2-inch height, dark contrasting color, of a material suitable for the application. Stencils shall be bold and clear on all stenciled pipes. Blurred or smeared identification is not acceptable.
 - 1. For HVAC equipment, provide a permanently affixed, weather-resistant label to identify the areas served.
- C. Valves: Provide each valve with a stamped metal tag secured to the valve. Tag shall indicate the valve number, service and function. Provide two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Drawings shall be neat and easily readable. Provide a typed valve chart, listing the valve number, size, location, function, normal operating position, for each valve. List valves by system, i.e., domestic cold water, hot water, chilled water, etc. The titles will be lettered on bands. Upper case letters and Arabic numerals will be used. Tags shall be stamped brass with at least 1-1/2" in diameter with depressed block characters 1/4" high. Tags shall be secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.
- D. Ductwork: Identify ductwork at or near the fan with stenciled signs on insulated ductwork or engraved laminated plastic signs secured by rustproof screws on un-insulated ductwork. Sign shall identify air conditioning system or fan unit and area served.
- E. Piping
 - 1. Provide color-coded pipe labels indicating the service of the pipe and the direction of flow. Colors shall be used for painting and banding of all piping in accordance with the **Identification Table** in this section. Selection of coating system (enamel, epoxy, or urethane) to be determined based upon service requirements.
 - 2. Where pipes are too small pipes or not readily accessible for label application, a brass identification tag will be securely fastened at appropriate locations. Tags will be at least 1-1/2" in diameter, with depressed block character 1/4" high.
 - 3. Labels in vinyl material shall be provided with permanent adhesive for interior application only to clear dry pipe and/or insulation jacketing. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.
 - 4. Attach pipe markers to lower quarter of the pipe on overhead horizontal runs and on the centerline of vertical piping where view is not obstructed.
 - 5. Provide band and letter size for all piping systems as listed below:

Width of Size of Letters and Outside Diameter of Pipe Covering

Color Band

Numerals

1/2" to 1-1/4"

2" 1/2" 1-1/2" to 2" 2" 3/4"

2-1/2" to 3"

2"

1"

3-1/2" to 6"

6"

1-1/4"

6. Locations: Label pipes at the following points on each piping system:
- Adjacent to each valve in piping system.
 - At every point of entry and exit where piping passes through a wall.
 - On each pipe riser and junction.
 - At a maximum interval of 20 feet on pipelines exposed and concealed above accessible ceilings.
 - Adjacent to all special fittings (regulating valves, etc.) in piping systems.
 - At every access door.
 - At all changes in elevation or direction.

- F. Control System Devices: All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the Contract Drawings.

Identification Table

Piping System/ Equipment	Description	Label	Label Color Scheme Letter Color on Background Color	Pipe/Equipment Color	Band Color
Chilled Water	Chilled Water Supply	CHWS	BLACK on WHITE	Aluminum Metal Jacket or White Sherwin Williams PILLAR WHITE SW 4029	Blue - SherwinWilliams SAFETY BLUE SW 4086
Chilled Water	Chilled Water Return	CHWR	BLACK on WHITE	Aluminum Metal Jacket or White Sherwin Williams PILLAR WHITE SW 4029	Blue - SherwinWilliams SAFETY BLUE SW 4086

2.3 GENERAL CONSTRUCTION COMPONENTS

- A. Access Doors (ADs)
- Steel frame and door, surface mounted, factory primed, 150° opening, flush, screwdriver operated cam lock, minimum 24" x 24" except as approved, but larger

where required for proper access. Where ADs are installed in general construction with a pattern, match AD dimensions to this pattern. Milcor, Krueger, OAE.

- a. Sheet Rock Wall or Ceiling: With drywall bead on frame, Milcor Style DW.
- b. Plaster Wall or Ceiling: Milcor Style K.
- c. Masonry Walls: Milcor Style M.
- d. 1-hr and 2-hr rated walls: UL Listed for 1.5-hr Class B Fire Rating, self-closing and self-latching. Milcor Style UFR.
- e. Suspended Ceilings: Milcor Style AT.
- f. Fire Rated Suspended Ceilings: Milcor Style ATR.

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL REQUIREMENTS

- A. Cooperation with Other Trades: Refer to other parts of these Specifications covering the work of other trades which must be carried on in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. Be responsible for the size and location of all openings, foundations, etc.
- B. Trenching and Backfilling: Provide all excavation, trenching and backfilling required for the installation of the work of this division.
- C. Manufacturer's Instructions: Install all products in accordance with manufacturers' recommendations and the requirements of any applicable listings. If manufacturers' recommendations and/or requirements of applicable listings conflict with plans and specifications, report such conflicts to the Owner's Representative.
- D. Field Measurements: Verify all dimensions and conditions governing the work. Examine adjoining work on which the work of this Division is dependent and report any deficiencies.
- E. Do not compromise the building structural, fire resistant construction or vapor barrier system.
- F. Supports for Equipment and Systems: Foundations and structural supports for equipment will generally be provided by others. The contractor for this division shall provide supplementary supports as required to support equipment, distribution systems, and other components installed under this division. Prior to installing mechanical work, examine foundations and supports to ensure they are adequate to properly support the equipment. Provide all necessary foundations, structures, supports, inserts, sleeves, etc., for installation of mechanical and plumbing equipment, ductwork and piping, etc. Coordinate installation of such devices with all disciplines. Verify that the devices and supports are adequate as intended and do not overload the building structure.
- G. Concealed or Buried Work: For work which is underground, or which will be concealed by building construction, provide digital photographs to document the installation throughout the construction project, but not less than weekly. Include plans indicating

where the photographs were taken. Notify the OR of when the work will be complete and provide OR a minimum five-day period to inspect the work after completion but prior to when it is backfilled or concealed by building construction.

- H. Access Doors: Provide as required for access to valves, dampers, controls, or other items for which access is required for either operation or servicing. The type of access door shall be as required by the room finish schedule.
- I. Alignment of Flexible Couplings: Flexible couplings between motors and driven equipment shall be aligned by a qualified service technician after the equipment is installed and ready for operation. Align equipment per manufacturer's recommendations under operating conditions and temperature. Provide written certification that each device has been so aligned.
- J. Lubrication: Provide all oil for the operation of all equipment until acceptance. Be responsible for all damage to bearings while the equipment is being operated by Contractor up to the date of acceptance of the equipment. Protect all bearings and shafts during installation and thoroughly grease shafts to prevent corrosion. Bearings for items of mechanical equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.
- K. Tests: All tests shall be conducted in the presence of the designated and authorized Owner's Representative. Notify the Owner's one week in advance of all tests. Requirements for testing are specified under the sections covering the various systems. Provide all necessary equipment, materials, and labor to perform the required tests.
- L. Protection of Material and Equipment:
 - 1. Protect all work, materials and equipment furnished and installed under Division 23, whether incorporated in the building or not.
 - 2. All items of mechanical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building or shall be otherwise protected from the weather in a suitable manner as approved.
 - 3. Protect all work and be responsible for all damage done to property, equipment and materials. Coordinate material storage with the Owner's Representative.
 - 4. Pipe and duct openings shall be closed with caps or plugs or covered to prevent lodgment of dirt or trash during the course of installation. Plumbing fixtures shall not be used by the construction forces. At the completion of the work clean and polish fixtures, equipment, and materials prior to turning them over to the Owner.

3.2 DRAWINGS

- A. The drawings show the general arrangement of the piping, ductwork, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Where discrepancies occur between Plans and Specifications, the more stringent shall govern. All Contract Documents shall be considered as part of the work. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories, which may be required. Investigate the structural and finish conditions affecting the work and arrange the work, accordingly, providing fittings, valves, and

accessories as required to meet such conditions. Show any such changes on the Record Drawings.

- B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, submit an RFI.
- C. Install equipment, piping, ductwork, and electrical systems with proper clearance for operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions, etc. Include proper clearance in front of and above electrical equipment as defined by the National Electric Code (NEC). Piping and ductwork systems shall not be routed through or above electrical equipment rooms, telecommunications rooms, elevator machine rooms, or electrical equipment spaces within mechanical equipment rooms.
- D. Arrange all concealed mechanical systems carefully to fit within the available space without interference with adjacent structural and electrical systems. Make all necessary provisions for penetrations of piping and ductwork, including sleeves and blockouts in structural systems. The exact location of all exposed mechanical systems, including grilles, registers, and diffusers; access doors; sprinkler heads; piping and ductwork exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it relates to the aesthetic design for the facility.

3.3 INTERRUPTING SERVICES

- A. Coordinate the installation of all work within the building in order to minimize interference with the operation of existing building mechanical, plumbing, fire protection, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without written review and authorization.

3.4 CONCRETE BASES AND HOUSEKEEPING PADS

- A. Concrete bases and housekeeping pads shall be installed under all pieces of mechanical equipment unless specifically deleted by the Specifications or Drawings.
- B. Be responsible for the accurate dimensions of all pads and bases and furnish and install all vibration isolators, anchor bolts, etc.
- C. Provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the Drawings. Pad foundations shall be 4 inches high minimum, unless otherwise indicated on the Drawings. Chamfer edges shall be 1 inch. Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.

- D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1 inch larger than bolt diameter. Anchor bolts shall be high strength steel J-shape. Anchor bolt design shall be arranged and paid for by the Contractor.
- E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, and then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

3.5 PRESSURE RELIEF DEVICES

- A. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

3.6 INSTALLATION CHECK

- A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the installation for the equipment listed below. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are approved and accepted.
- B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and (4) has been operated under full load conditions and that it has operated satisfactorily.
- C. Equipment requiring installation check includes the following:
 - Air Cooled Chiller
 - Pumps
 - Facility Management System

3.7 OPERATION PRIOR TO ACCEPTANCE

- A. Operation of equipment and systems for the benefit of the Owner prior to substantial completion will be allowed provided that a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.
- B. Operation of equipment and systems for the benefit of the Contractor, except for the purposes of testing and balancing, will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

- A. At completion of the project provide two complete bound sets of the following documents, along with two CDs containing searchable PDFs of these documents. Organize bound information in a logical fashion with a table of contents and tabs for the different sections. Organize PDFs in a logical fashion with bookmarks to assist the operating personnel in

retrieving desired data. Provide minimum two 1-hour sessions to instruct Owner's facility personnel in how to find information in the bound O&Ms and the PDFs. Take attendance and submit the attendance list to the Owner's Representative. Include the following:

1. Approved Submittals.
 2. Test reports.
 3. O&M manuals and instructions covering all equipment supplied under this Division, with all non-applicable information crossed out. Clearly identify all required routine maintenance. Include parts lists.
 4. A master Lubrication Chart listing each piece of equipment, the recommended oil or grease, and the recommended frequency of lubrication.
 5. The names and addresses of at least one service agency capable of providing required maintenance for each item of equipment supplied.
 6. Complete temperature control diagrams including control descriptions, system sequence of operation, operating instructions, control system maintenance and calibration information, wiring diagrams, and all control setpoints. See Section 23 09 00 for additional requirements.
- B. Submit O&M manuals for review and distribution to the Owner not less than two weeks prior to the date scheduled for O&M instructions as specified.
- C. Demonstrate proper system operation to the owner's operating staff. Provide the services of the contractor and subcontractors (e.g., mechanical, T&B, temperature control, etc.), as required to properly demonstrate system operation.
- D. Provide the necessary skilled labor and helpers to operate the mechanical systems and equipment for a period of 2 days of eight hours each. During this period, instruct the owner's facility staff fully in the operations, adjustment and maintenance of all equipment provided. Provide at least two weeks advanced notice, with a written schedule of each training session, the subject of the session, the Contractors' Representatives who plan to attend the session, and the time for each session. Take attendance and submit attendance sheets to the Owner's Representative.

3.9 RECORD DRAWINGS

- A. Maintain a full-size set of marked-up prints showing the installed location and arrangement of all work under this division, and in particular where changes were made during construction. Keep record drawings accurate and up to date throughout the construction period. Owner's Agents may request to review record drawings during construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFIs, bulletins, and change orders neatly taped or attached to record drawing set. At the completion of the project send the Engineer full-size plans clearly showing all changes from the original design marked up in red so as to facilitate the Engineer incorporating these changes into the Engineer's CAD files. Forward record drawings to the Owner's Representative prior to submitting a request for substantial completion.

3.10 SITE VISITS AND OBSERVATION OF CONSTRUCTION

- A. The Engineer may make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the work so as to determine if such work is proceeding in general accordance with the Contract Documents. This observation will not release the Contractor from his responsibility to supervise, direct, and control all construction work and activities. The Engineer has no authority over, or responsibility for means, methods, techniques, sequences, or procedures of construction or for safety precautions and programs, or for failure of the Contractor to comply with applicable laws, regulations, or codes.
- B. Prior to substantial completion, request that the Engineer provide a final observation visit. Complete the attached "Final Observation Checklist," and include it with this request. For any items that are not applicable, mark them "N/A."

3.11 PROJECT CLOSEOUT

- A. Submit written certification that all work complies with the specifications and applicable codes. Submit certifications and acceptance certificates including proof of delivery of record drawings, O&M manuals, spare parts required, and equipment warranties.

END OF SECTION 23 0500

Project: _____

Date Submitted: _____

General Contractor: _____

Date of Final Mechanical System: _____

Mechanical Contractor: _____

Observation Requested: _____

CONTRACTOR'S MECHANICAL CHECK LIST**(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)**

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

PIPING

- _____ 1. All HVAC pipe systems are insulated.
- _____ 2. All pipe systems are identified with specified labels and directional arrows.
- _____ 3. Floor sinks and drain grates are cleaned and debris removed.
- _____ 4. Valve tags are installed.
- _____ 5. Piping connections have been completed to Owner-furnished equipment and equipment furnished by other Contractors/Subcontractors.
- _____ 6. Drains and relief lines from HVAC equipment have been installed and secured in a proper manner.
- _____ 7. All equipment and areas of equipment have been cleaned and debris removed.
- _____ 8. All equipment required by the Specifications has been identified and/or numbered.
- _____ 9. Strainers/suction diffusers have been cleaned.
- _____ 10. Air has been vented from all coils and systems.
- _____ 11. Water systems have been cleaned (X) and pressure tested (P)
 - _____ Heating Hot Water
 - _____ Chilled Water
 - _____ Condensate Water
- _____ 12. Temperature control panels and devices have been labeled in accordance with the Specifications.
- _____ 13. All control valves have been piped as required by the Drawings.

- _____ 14. Controls systems are completed, and all control points are operating and recording properly.
- _____ 15. All temperature control tubing and wiring is installed and secured in accordance with the Specifications and the electrical code.
- _____ 16. All equipment isolators have been adjusted for specified deflection.
- _____ 17. All pump shafts and couplings have been aligned.
- _____ 18. Ductwork, coils, housing, diffusers, registers and grilles have been cleaned.
- _____ 19. Fire dampers are accessible and fully operational.
- _____ 20. All HVAC equipment has been lubricated.
- _____ 21. HVAC equipment has been labeled in accordance with the Specifications.
- _____ 22. Freezestats have been tested ensuring fan shutdown and full damper closure.
- _____ 23. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.
- _____ 24. Testing and balancing has been completed, and deficiencies noted have been corrected.
- _____ 25. Operator training for temperature controls has taken place.

TEMPERATURE CONTROLS

- _____ 1. Equipment room shutdown have been tested.

GENERAL ITEMS

The following specified items have been submitted:

- _____ 1. Record Drawings (to be submitted prior to final payment to the Contractor).
- _____ 2. Operation and maintenance manuals.
- _____ 3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 23 0500).
- _____ 4. Testing and balancing reports.
- _____ 5. Test kits furnished to Owner.
 - _____ Flow Measuring Devices
 - _____ Flow Balance Valves
 - _____ Flow Control Devices
- _____ 6. Temperature control schematics and sequence of operation.

DIVISION 23 SUBSTITUTION REQUEST FORM (SRF)**TO: RAMIREZ SIMON ENGINEERING, LLC****PROJECT: WILLIAMSON COUNTY ESOC DATA CENTER COOLING UPGRADES**

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐

If YES, explain: _____

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐

3. List differences between proposed substitutions and specified item.

Specified Item

Proposed Substitution

_____4. Does substitution affect Drawing dimensions? YES ☐ NO ☐

5. What affect does substitution have on other trades? _____

6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐

If YES, explain: _____

7. Will substitution affect progress schedule? YES ☐ NO ☐

If YES, explain: _____

8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐

If YES, explain: _____

9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____ Date: _____

Address: _____

Signature: _____ Telephone: _____

For Engineer's Use Only

Accepted _____ Not Accepted _____ Received Too Late _____

By: _____ Date: _____

Remarks: _____

BIM/CAD AGREEMENT**PROJECT: WILLIAMSON COUNTY ESOC DATA CENTER COOLING UPGRADES**

Contractor understands and acknowledges by signature below that by transferring BIM/CAD documents for contractor/subcontractor use, Ramirez Simon Engineering, LLC (RSE) disclaims all warranties and obligations or liabilities for damages, including, but not limited to, consequential damages arising from or in connection with the use or performance of the documents. Contractor shall use documents at contractor's sole risk and without liability, risk or legal expose to RSE. Documents are diagrammatic in nature developed to display the general scope of the project. It is the contractor's responsibility to verify dimensional requirements.

Contractor agrees to limit document distribution and use to only contractor employees or subcontractors on this project. Contractor shall not distribute documents to any other entities without written consent from RSE.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2: _____

Date: _____

SECTION 23 0501
DEMOLITION FOR HVAC

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions, and the General Requirements.

1.2 RELATED SECTIONS

- A. See Section 23 05 00, for Common Work Requirements for HVAC.

1.3 SCOPE OF WORK

- A. The terms "demolish" and "remove" shall mean disconnect, cart away, and dispose of off- site. Components to be demolished or removed include all materials, equipment, building construction, and other components as indicated. Components to be demolished shall become the property of the contractor, and contractor may dispose of them by either landfilling or by selling salvageable parts and recyclable materials to legitimate third parties.
- B. Asbestos abatement will be by others and is not included in this contract. Advise Owner sufficiently in advance of demolition work so that Owner may arrange to have asbestos removed without delaying demolition or construction work.
- C. The Owner retains the first right of refusal on all components to be removed. When requested, remove components carefully and deposit components in locations as directed by the Owner.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 GENERAL

- A. Within four weeks after notice to proceed, and a minimum of two weeks prior to any demolition activities, submit a project schedule indicating all demolition work. Schedule all work to minimize interruptions in utility services to the facility. Interruptions generally will be allowed only outside normal operating hours. Sequence all work in accordance with the drawings and the Project Manual.
- B. Take care not to damage equipment, materials, components, and building construction which is to remain in service. Provide blind flanges, caps, etc., so as to prevent accidental discharge of water, etc.
- C. Do not interfere with the Owner's access to building and equipment. If any activities cause interference which is objectionable to the Owner, contractor shall modify his

means and methods, or reschedule those activities outside occupied hours at no additional cost to the Owner.

- D. Where existing systems must remain in service during the construction project, make whatever provisions are necessary to accomplish this. This includes providing blind flanges and caps, temporary insulation, duct caps, etc., to allow for proper system operation.

3.2 EQUIPMENT

- A. General: Disconnect and remove piping, ductwork, controls, power, and equipment supports. Wherever possible, remove equipment as a whole. Do not cut up equipment in place unless approved in advance by the Owner.

3.3 PIPING

- A. Disconnect piping as indicated, and remove all piping not required in the final, upgraded condition of the systems. This includes removal back to the headers and mains which must remain in service. The existing valving may not hold tight. Arrange in advance for shutdowns as required. Provide caps, blind flanges, etc. as indicated on drawings, as required to facilitate construction activities, and as required to facilitate owner's use of the system.
- B. Remove all components in piping system, including valves, fittings, flanges, strainers, anchors, guides, hangers, supports, supplementary steel, attachments to structure, instrumentation, insulation, etc.
- C. Patch all openings in walls, floors, roofs, partitions, gratings, etc., which remain after piping is removed.
- D. Provide vents and drains in the piping which will remain in service, where necessary to facilitate refilling, venting, and future system operation.

3.4 CONTROLS

- A. Remove all controls associated with equipment, piping and ductwork which are to be removed. Controls shall include instrumentation, control panels, wiring, conduits, tubing, supports, and attachments to structure. Where wiring is run in conduit in concealed locations, remove the wiring, cap both ends of conduit, and label conduit as "ABANDONED" at both ends.

3.5 ELECTRIC POWER

- A. Remove all electric power associated with equipment, controls and accessories which are to be removed. Electric power shall include starters, disconnects, wiring and conduit from MCC's and distribution panels to local starters and disconnects, wiring and conduit from local starters and disconnects to equipment, supports, attachments to structure, and concrete housekeeping pads. Label all associated breakers as "SPARE." Where MCC's serve equipment to be removed and no new equipment is to be served from the same starter, leave the starter in place and label it as "Spare Size X Starter."
- B. Where wiring runs in conduit within concealed locations, remove the conductors, cap both

ends of conduit, and label conduit as "ABANDONED" at both ends. Where wiring runs below grade, remove conductors, cap conduit at both ends, and abandon in place. Where wiring runs below concrete floor slabs, chip out concrete around conduit, remove conduit to bottom of slab level, and patch floor to match adjacent surfaces.

3.6 EQUIPMENT SUPPORTS

- A. Housekeeping Pads: Remove housekeeping pads for equipment to be removed. Remove all tripping hazards and resurface floor to match surrounding floor.
- B. Equipment Foundations: Remove foundations, remove all tripping hazards, backfill as required, compact to 95% Standard Proctor Density, and pour floor slab to match existing.
- C. Support Steel: Remove all support steel including attachments to building or to grade.

3.7 MEANS OF ACCESS

- A. Remove all service platforms, catwalks, ladders, etc. which are required solely for the equipment, valves, and instrumentation which are being removed as part of this work.

END OF SECTION 23 0501

SECTION 23 0504
PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.
- B. Lead Ban: All piping, solder and flux used in the installation of piping systems furnished and installed under Division 23, shall be lead free.

1.2 RELATED SECTIONS

- A. Section 23 05 00, Common Work Requirements for HVAC.
- B. Section 23 2114 Chilled Water System & Equipment.

1.3 SUBMITTAL DATA

- A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type, and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

- A. Piping system materials shall be furnished as specified under the Sections describing the various piping systems. Pipe fittings shall be compatible with the piping systems in which they are installed.
- B. Socket weld fittings shall be Schedule 40, 2000 pound or Schedule 80, 3000-pound construction, as specified in the applicable Sections of this Specification, conforming to ANSI B16.11, as manufactured by Grinnell or equivalent.
- C. Pipe fittings for copper piping system shall be wrought copper conforming to ANSI B16.22. Cast brass fittings conforming to ANSI B16.23, may be utilized for sanitary drainage, waste and vent systems, HVAC gravity condensate drainage system, and other non-pressure applications.
- D. Bronze flanges, Class 125 and Class 150, shall conform to ANSI B16.24.

2.2 FLOOR, WALL AND CEILING PLATES

- A. Where uncovered, exposed pipes pass through finished floors, finished walls, or finished ceilings, they shall be fitted with chromium plated spun brass escutcheon plates. Plates shall be large enough to completely close the hole around the pipe and shall be not less than 1-1/2" or more than 2-1/2" larger than the diameter of the pipes. All plates shall be securely held in place.

2.3 UNIONS

- A. Piping 2-1/2" and larger shall be provided with bolted flange union connections. Weld flanges and bolting shall conform to ANSI B16.5. Bronze flanges shall conform to ANSI B16.24. Flange class shall be as specified in the applicable Sections of the Specifications.
- B. Malleable iron grooved joint unions with brass to iron seats, Class 125, 250, or 300, as required by the application and compatibility requirements with the piping system fitting classification, conforming to MSS SP-77 and ANSI B16.39, shall be provided in piping systems 2" and smaller. Copper unions conforming to ANSI B16.22 shall be provided in copper piping systems. Union connections shall be installed at all coils, control valves, equipment connections, and at other locations shown on the drawings, and required for proper system operation and maintenance.

2.4 DIELECTRIC FITTINGS

- A. Dielectric insulating fittings shall be provided to connect dissimilar metals, such as copper tubing to ferrous metal pipe. Connections 2" and smaller shall be threaded dielectric union conforming to ANSI B16.39. Connections 2-1/2" and larger shall be flange union with dielectric gasket and bolt sleeves, conforming to ANSI B16.42. Insulating fittings will not be required between bronze valves and copper piping, unless otherwise specified. Dielectric coupling is not permitted.

2.5 PIPE HANGERS AND SUPPORTS

- A. All piping shall be rigidly supported from the building structure by means of hanger assemblies properly selected and sized for the application in accordance with the manufacturer's recommendations and specifications. Pipe hangers shall be Grinnell, B-Line, or equivalent.
- B. No attempt has been made to show all required piping supports in all locations, either on the drawings or in the details. The absence of pipe supports and details on any drawing shall not relieve the Contractor of the responsibility for furnishing and installing proper hangers and supports throughout.
- C. Piping hangers shall be spaced on the scheduled maximum spacing and shall have hangers not more than one foot from each elbow and other changes in direction or elevation. Provide additional hangers and supports at valves, strainers, in-line pumps adjacent to flexible connections, and other required heavy components. Piping system shall be installed in an approved manner and shall not overload the building structural frame. Contractor shall provide additional hangers and miscellaneous steel supports as may be required to distribute the piping system load over multiple structural members where required or directed. Maximum allowable spacing for steel and copper piping, other than fire protection piping, shall be as scheduled in Table No. 1.

TABLE NO. 1**MAXIMUM SUPPORT SPACING FOR STEEL
AND COPPER PIPING SYSTEMS**

<u>Steel Piping</u>	<u>- Maximum Spacing</u>
1/2"	- 5'-0"
3/4" and 1"	- 6'-0"
1-1/4" through 2"	- 8'-0"
2-1/2" through 6"	- 10'-0"
8" through 12"	- 12'-0"
14" and larger	- 12'-0"
 <u>Copper Piping</u>	 <u>- Maximum Spacing</u>
3/4" through 2"	- 6'-0"
2-1/2" through 4"	- 8'-0"
5" and larger	- 10'-0"

- D. Round rods supporting the pipe hangers shall be of the minimum dimensions as scheduled in Table No. 2. Hanger rods shall be hot-rolled steel, ASTM A-36 or A575, galvanized, all-thread. Provide for controlling level and slope by turnbuckles or other approved means of adjustment and incorporate locknuts.

TABLE NO. 2**HANGER ROD SIZE FOR PIPE HANGER SUPPORTS**

1/2" to 2" pipe	- 3/8" rod
2-1/2" to 3" pipe	- 1/2" rod
4" to 5" pipe	- 5/8" rod
6" pipe	- 3/4" rod
8" to 12" pipe	- 7/8" rod
14" and 16" pipe	- 1" rod.
18" and 20" pipe	- 1-1/4" rod.

- E. Hangers, clamps and other support materials in contact with copper piping shall be copper or copper plated to prevent electrolysis. Hangers for copper piping shall be copper plated adjustable ring type Grinnell Fig. CT-269, adjustable swivel ring, Grinnell Fig. CT69, Fig. CT-65 or adjustable clevis type or equivalent. Provide minimum 10 mil plastic wrap around copper pipe at any ferrous point of attachment including trapeze hangers, clamps, and other supports.
- F. Hangers for steel shall be steel clevis type hangers, Grinnell Fig. 260 or equivalent.
- G. Hangers and associated hardware in crawlspace, under foundations, and in wet areas shall be hot dipped galvanized. Otherwise, hangers and hardware shall be cadmium plated.

- H. Where piping is installed side by side, the Contractor may support the piping utilizing trapeze type hanger assemblies. Horizontal trapeze member shall be galvanized steel channel, not less than 1-1/2" x 1-1/2" x 12" gauge, or Unistrut. Contractor shall provide heavier steel members as required for the load to be supported and the distance span. Hanger rods shall be as specified above, properly sized for the load supported but not less than 5/8" diameter. Un-insulated copper piping shall be isolated from the steel trapeze. Individual pipe shall be guided on the horizontal member at every other hanger point with 1/4" U-bolt fabricated from steel rod. Provide full circle galvanized sheetmetal insulation shield for insulated piping at trapeze hangers with U-bolt guide and galvanized sheetmetal insulation half-shield at other trapeze hangers. Insulation shield shall be 18 gauge minimum, Grinnell Fig. 167 or equivalent.
- I. As required for the proper control of the system expansion and contraction, and for heating hot water provide rolled type supports. Roller hangers shall be Grinnell Fig. 181 or equivalent and roll support for trapeze hangers and pipe racks shall be Grinnell Fig. 271 or equivalent complete with base plate.
- J. Special piping supports including wall support racks, floor mounting type supports shall be provided as indicated on the drawings, and as required for the proper support for the piping systems.
- K. Vertical piping shall be supported at each floor level by means of riser clamps, Grinnell Fig. 261 and Fig. G-121 copper clad for copper piping systems, or equivalent. Proper allowance for the expansion and contraction of the vertical risers shall be provided. Contractor shall submit shop drawings indicating proposed method for support and control of expansion and contraction of vertical piping.
- L. The use of pipe hooks, chains, or perforated iron for pipe hanger supports will not be permitted.
- M. All insulated piping systems specified in Section 23 07 00 Mechanical System Insulation, shall be provided with individual hangers sized to encircle the insulation. See applicable sections for insulation thickness requirements. The specified piping systems where supported by means of trapeze hangers shall not rest directly on the trapeze horizontal members. The insulation at hangers and trapeze hangers shall be protected by means of insulation shield, Grinnell Fig. 167, or equivalent. Grinnell Fig. 160 or equivalent, curved steel pipe saddle shall be provided at roll hangers. Contractor shall provide section of high-density calcium silicate insulation or thermal hanger shields as manufactured by Pipe Shields, Inc., or equivalent, at all insulation piping system hanger and support points for piping 1-1/2" or larger.
- N. Attachment of piping hangers to the building structure shall be provided in a manner approved by the Structural Engineer. The Contractor shall provide concrete inserts in the building construction at the time the concrete is poured, and hangers shall be attached to these inserts. Self-drilling expansion anchors, Federal Specification FF-S-325, may be used in concrete construction not less than 4" thick. Applied load shall not exceed manufacturer's approved ratings. Power driven fasteners may be used in existing concrete or masonry not less than 4" thick where approved by the Structural Engineer. Attachment to wood construction shall be by means of wood screws or lag bolts.

2.6 PIPE SLEEVES

- A. Pipe sleeves shall be furnished and set by the Contractor, and he shall be responsible for their proper and permanent location. Piping will not be permitted to pass through footings, beams or ribs except with written consent of the Architect. Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through gypboard stud walls and concrete, and masonry construction and at all fire and smoke rated walls and partitions. Pipe sleeves, except sleeves in footings and beams shall be equal to Pipe Shields Incorporated Model WFB for walls, DFB for decks, or QDFB for corrugated decks, or equivalent. Each sleeve shall be adjustable, with annular spacing packed with U.L. approved mineral fiber fire safing material. Where insulated piping is installed, calcium silicate inserts to match the insulation thickness and extending 1" past the sleeve on both ends, shall be provided. Pipe sleeves in concrete and masonry construction, footings and beams shall be Schedule 40 black steel pipe. Pipe sleeves in gypboard construction shall be galvanized steel metal. Sleeves shall be not less than 1" or more than 2" larger in diameter than the pipe to be installed. Pipe sleeves in floors shall extend 2" above finished floor in chases and equipment room areas unless otherwise approved by the Architect. Openings between piping and sleeves shall be made watertight with plastic cement installed to a minimum depth of 2". Where pipes pass through exterior walls, the annular space between the wall and the pipe shall be sealed by sealing elements made of synthetic rubber, pressure plates, and cadmium plated bolts as manufactured by Link-Seal, or equivalent.
- B. Un-insulated piping passing through fire walls, smoke wall, sound control walls and air plenum separations shall be sealed airtight to the adjacent construction by means of UL approved fireproof caulking materials.
- C. Insulated piping passing through fire walls and smoke walls shall be provided with a section of UL approved fire safing insulation to match the required insulation thickness or Pipe Shields, Inc. pipe shield sleeves as specified above at the required wall penetrations. The space between the piping sleeve penetration and the adjacent wall Construction shall be sealed airtight with UL approved fireproof caulking material. Penetrations of gypboard sound walls and air plenum separators shall be caulked airtight with an approved caulking compound.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Provide and erect, according to the best practices of the trade, all piping shown on drawings and required for the complete installation of these systems. The piping shown on the drawings shall be considered as diagrammatic for clearness in indicating the general run and connections and may or may not in all parts be shown in its true position. The piping may have to be offset, lowered, or raised as required or as directed at the site. This does not relieve the Contractor from responsibility for the proper erection of systems or piping in every respect suitable for the work intended as described in the specifications. In the erection of all piping, it shall be properly supported, and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed.

by reaming or other cleaning methods. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging. All piping shall be arranged so as not to interfere with removal and maintenance of equipment or filters or devices; and so as not to block access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment including refrigeration machines. All piping shall be so installed to ensure noiseless circulation. All valves and specialties shall be so placed to permit easy operation and access, and all valves shall be regulated, packed, and adjusted at the completion of the work before final acceptance. All piping shall be erected to ensure proper draining.

3.2 JOINTS

- A. Caulked Joints: Resilient molded gasket joints or "Ty-Seal" may be used for sanitary soil, waste and vent piping. No-hub pipe and fittings will be accepted with the exception that no-hub pipe and fittings shall not be allowed for buried installation.
- B. Solder Joints: Copper tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings shall be made with a non-corrosive paste flux and solid 95-5 tin-antimony wire solder, unless otherwise specified. Cored solder will not be permitted. 50/50 lead solder shall not be permitted for any applications.
- C. Press Joints are allowed for copper piping application for chilled water. Press fittings shall be Viega ProPress or Viega ProPress XL with maximum operating pressure of 200 psi. and temperature range from 0°F to 250°F. Fittings shall include an EPDM sealing element to provide permanent leak-proof connection. ProPress fittings shall be installed following manufacturer's recommendations.
- D. Flanged Joints: Flanged joints shall conform to the American Standard for cast iron flanged pipe fittings, Class 125, 150 or 300 as specified in the applicable Sections of these specifications. Gaskets shall be full face or ring type, non-asbestos, suitable for the service on which used.

3.3 PUMP AND EQUIPMENT CONNECTIONS

- A. All piping connecting to pumps and other equipment whether connected utilizing flexible connectors or with solid pipe connectors, shall be installed without strain at the pipe connection of the equipment. The Contractor shall be required, if so directed, to disconnect piping to demonstrate that piping has been so connected.

3.4 FLUSHING, DRAINING AND CLEANING PIPE SYSTEMS

- A. The Contractor shall flush out all water systems with water before placing them in operation. Other systems shall be cleaned by blowing them out with compressed air or nitrogen. After systems are in operation and during the test period, all strainer screens shall be removed and thoroughly cleaned.
- B. Piping flushing shall conform to the requirements of 23 2114, Chilled Water System and Equipment

3.5 TESTING

- A. Before any insulation is installed or before piping is covered or enclosed, all piping systems shall be tested and proven tight at not less than 150% of the maximum service pressure which the piping systems will be required to handle. Piping system tests shall be as specified in the applicable sections of this Specification. All tests shall be witnessed and approved by the Owner's representative.
- B. All labor, material, and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying the tests. To perform tests, all lines shall be flushed and cleaned.
- C. All safety measures required by codes or ordinances or reasonably applicable to the situation shall be provided by the Contractor in conjunction with the testing of the piping systems.
- D. Equipment or piping to be pressure tested shall not be insulated, covered, or concealed prior to that test. Tie rods, clamps etc., shall be in place and fastened.
- E. Tests shall not be used to establish pressure ratings.
- F. Protect all piping and equipment against over pressure, collapse from vacuum, and hydraulic shock during the filling, testing, and draining procedures. Seats of iron valves shall not be subjected to a pressure more than the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating.
- G. Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60°F. Note that some applicable codes may require testing above a specified minimum temperature.
- H. Remove from the system all pumps, turbines, traps, expansion joints, instruments, control valves, safety valves, rupture discs, orifice plates, etc., which might be damaged by the test. Also remove all items such as orifice plates which might trap air in a system to be hydrostatically tested. Disconnect all instruments and air lines where copper tubing starts.
- I. Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.
- J. During hydrostatic testing of lines, provide temporary supports to prevent overstressing supports or hangers. When tests are completed, remove all temporary supports, locks, stops, etc., and adjust supports for their cold load and alignment.

END OF SECTION 23 0504

SECTION 23 0505
PIPING SPECIALTIES

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform to applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

- A. Section 23 05 00, Common Work Requirements.
- B. Section 23 05 04, Pipe and Pipe Fittings.
- C. Section 23 05 23, Valves.
- D. Section 23 07 00, HVAC Insulation.

1.3 SUBMITTAL DATA

- A. Furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications, and approval of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

2.1 STRAINERS

- A. Strainers suitable for the application shall be furnished and installed on the high-pressure side of pressure reducing valves, pressure regulating valves, suction side of pumps, inlet of indicating and control instruments and equipment subject to sediment damage, and as shown on the drawings. Strainers shall be "Y"-type unless basket strainers are indicated. Tee-type strainers will not be accepted. Strainer element shall be removable without disconnecting piping. Every strainer shall be provided with a blow-off connection not less than 1/2" NPT and provided with a ball valve the full size of the strainer outlet tapping. Strainers located outside of mechanical equipment rooms and above ceilings shall be provided with hose connection and cap on the outlet of the blowoff valve. Strainers shall be Spirax Sarco, Armstrong, Febco, Grinnell, Hoffman, Keckley, Metraflex, Mueller, Yarway, or equivalent.
- B. Strainers 2" and under for copper piping systems shall be threaded connection, bronze body, 250 PSIG maximum working pressure, suitable for steam, oil, gas and liquid service, Sarco BT or equivalent.
- C. Strainers 2" and under for steel piping systems shall be threaded connection, bronze body, as specified above or cast-iron body as specified herein, except all strainers in galvanized steel domestic water systems shall be bronze body. Cast iron strainers shall be threaded connection, 250 PSIG maximum working pressure, suitable for steam, oil, gas and liquid service, Sarco IT or equivalent.

- D. Strainers 2-1/2 inches or larger shall be standard flanged connection ANSI-250, cast iron body, suitable for steam, oil, gas, and liquid service, 250 maximum working pressure at 406° F maximum temperature, Sarco AF-250, or equivalent.
- E. Basket strainers 2" and larger shall be standard flanged ANSI-250, cast iron body bolted cover, Type 304 stainless steel screen, suitable for steam or liquid service, 250 PSIG maximum working pressure at 406°F maximum temperature, Sarco 528-B-250, or equivalent.

2.2 PRESSURE GAUGES

- A. 2.5-inch glycerin filled, SS case, 1.5% accuracy, dual scale (PSI & KPA), bronze bourdon tube and 0.25-inch NPT connection, brass snubber with properly selected filter disc for the application, and needle valve with knurled brass or ABS plastic handle. Provide multiple needle valves where a single pressure gauge is used to measure pressure at multiple points. Gauges shall be Winters, Weiss, Ashcroft, Terice, Weksler, or approved substitution.
- B. Select pressure range so that the normal operating pressure is approximately 50% of the scale range. Provide compound and vacuum gauges where required by the application.
- C. Install gauges so they are easily readable from normal operator level. Where the sensing location is not convenient to the operator, install the gauge and needle valves at a location easily read from normal operator level, extend piping from there to the sensing point on the main pipe, and provide a ball valve for isolation at the main. In addition, provide drain and vent valves to facilitate removing air and water from the sensing line.

2.3 THERMOMETER AND THERMOMETER WELLS

- A. Either liquid filled or digital type, vari-angle, 3-1/2" stem for pipe sizes through 6" and 6" stem for pipe sizes 8" and larger, dual scale (degrees F & C), separable brass socket, extension neck where installed in insulated piping, and accuracy 1% of range. Winters, Weiss, Moeller, Terice, Weksler, Duro, or equivalent.
 - 1. Liquid Filled Type: 9" case, straight form, V-shaped, high pressure die cast aluminum, baked enamel finish, with heavy glass-protected front firmly secured with spring action, and organic liquid filled magnifying lens. Winters 9IT or approved equal.
 - 2. Digital Type: May be used both indoors and in outdoor locations not exposed to sunlight, high impact ABS plastic housing, suitable for operation at 16 Lux. Winters 9IT or approved equal.
- B. Ranges: Provide the following ranges except where otherwise indicated:

Chilled Water	0-120 degrees F
Heating water	30-240 degrees F

2.4 MANUAL AIR VENTS

- A. Provide manual air vents at the high point of all liquid piping system and as otherwise required for proper air elimination and liquid circulation.
- B. Manual air vents shall be 1/2" brass ball valves as specified in Section 23 05 23. Provide brass hose connection and plug on valve outlet.

2.5 AUTOMATIC AIR VENT

- A. Provide automatic air vents for all separators, at the high point of all hydronic systems. Automatic air vents shall be 3/4" size, minimum. Provide manual shut-off ball valve between automatic air vent and piping system. Automatic air vents shall be float type, 150 PSIG maximum working pressure, 3/4" NPT system connection, Amtrol Model No. 720, Taco, Armstrong, Watson-McDaniel, Hofmann, or equivalent.

2.6 MANUAL DRAIN VALVES

- A. Provide manual drain valves at the low points of all liquid piping systems, at any branch connection serving three or more terminal units to avoid having to drain entire system and as otherwise required for proper draining of systems. Manual drain valves shall be sized not less than 3/4" size, brass ball valve, as specified in Section 23 05 23. Pipe discharge from drain valves to floor drain, floor sink, or as otherwise directed for indirect discharge into sanitary sewer system. For drain valves located above ceiling or in location outside mechanical equipment areas provide brass hose connection and cap for valve discharge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All specialties shall be installed in accordance with the best standard practices and as recommended by the manufacturer.
- B. Install thermometers so they are easily readable from operator level.
- C. Where thermometers, gauges, vents, and test fittings occur in insulated piping systems or on insulated equipment, extension necks shall be provided to extend beyond the insulation.

3.2 AIR VENTS

- A. Manual air vents shall be installed as specified herein and at the high points in all piping systems.
- B. Automatic air vents shall be installed as specified herein and at locations indicated on the drawings. Automatic air vents shall be installed level and in accordance with manufacturer's directions to properly vent system, complete with individual isolation valves.

3.3 STRAINERS

- A. All strainer screens, including basket strainers and suction diffusers, shall be removed and cleaned prior to commencing testing and balancing work and shall be maintained clean

through project final acceptance by the Owner. Suction diffusers start-up strainers shall be removed prior to final system testing and balancing work.

3.4 TEST AND ADJUSTMENT

- A. Field adjusts all water pressure regulating valves, flow switches, water level controls, and specialties to provide required system operation.
- B. Field test and verify the operation of all safety devices including water relief valves and temperature and pressure relief valves.

END OF SECTION 23 0505

SECTION 23 0523
VALVES

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. All Valves shall conform with current applicable provisions of the General Conditions, Supplementary Conditions, and General Requirements.
- B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.
- C. Lead Ban: Valves shall be lead free.

1.2 RELATED SECTIONS

- A. Section 23 05 00 for Common Work Requirements for HVAC.
- B. Section 23 05 04 for Pipe and Pipe Fittings.
- C. Section 25 00 00 for Automatic Temperature Control Valves.

1.3 SCOPE

- A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

- A. All Check valve or Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.
- B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.
- C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Grinnell, Victaulic, Nibco, or Dezurik, or equivalent. Butterfly valves may be used for closed circuit chilled water, heating hot water (200°F maximum) run-around coil and heat pump circulating water systems and for condensing water systems. Butterfly valves shall not be used for domestic water or other non-specified service.
- D. Ball valves shall be utilized in lieu of gate valves and globe valves for all HVAC and plumbing systems for sizes 2" and smaller.
- E. Butterfly valves shall be utilized for all HVAC and plumbing systems for sizes 2-1/2" and larger.
- F. All valves of the same type shall be products of a single manufacturer unless otherwise approved by Owner's Representative.

PART 2 - PRODUCTS

2.1 GENERAL SERVICE VALVES, HVAC AND PLUMBING SYSTEMS

- A. Check Valves - 2" and Smaller, Class 125: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 125 construction, Y-pattern, swing type design, teflon seat, disc for steam service, Buna-N for water service. Milwaukee 509 (Threaded) or equivalent; Milwaukee 1509 (Solder) or equivalent.
- B. Check Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, Y-pattern, swing type design, bronze seat, composition disc, teflon seat disc for steam service, Buna-N for water service. Milwaukee 510 (Threaded) or equivalent; Milwaukee 1510 (Solder) or equivalent.
- C. Check Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 300 construction, Y-pattern, swing type design, bronze regrinding disc. Milwaukee 507 (Threaded) or equivalent.
- D. Check Valves - 2 1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 125 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2974M or equivalent.
- E. Check Valves - 2 1/2" and Larger, Class 250: Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 250 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2970 or equivalent.

2.2 BUTTERFLY VALVES

- A. Valves 2-1/2" and larger shall be full lug pattern, ASTM A-216, Class B cast iron body, 416-SS stems and nosing, ductile iron disc, EPDM liner and seats (-30°F to 275°F) w/rigid phenolic cartridge, 200 PSIG working pressure with Bubble tight shut-off. Valves shall be for mounting between flanges with lugs drilled and tapped so that pipe may be disconnected on either side of valve with opposite end remaining under pressure. Milwaukee ML-123-E or equivalent.
- B. Valves 4" and smaller shall be provided with level handler operator with spring loaded lock stops. Valves 5" and larger shall be furnished with manual gear operator with hand wheel.
- C. Valves installed for insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing.
- D. Butterfly valves furnished for use in grooved piping system shall meet the material specification requirements as specified herein.

2.3 BALL VALVES

- A. Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, 600 PSI W.O.G. Two-piece body, stainless steel balls and stem, blowout proof stem, reinforced TFE seats, non-asbestos packing. Milwaukee BA-100 (threaded) or equivalent. Milwaukee BA-150 (solder) or equivalent.

- B. Valves installed on insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing. Cutting or notching of the insulation or bending of handles shall not be permitted.

2.4 BALANCE VALVES

- C. Valves 2" and smaller: Ball valve, bronze, Class 150 construction, 600 PSI W.O.G., Two-piece body, Milwaukee BA-100 (threaded). Milwaukee BA-150 (soldered), as specified herein or equivalent.
- D. Valves 2-1/2" and larger: Lubricated plug valve, cast iron construction, 175 PSI W.O.G., Class 125 flange connections, level handle for valves 4" and smaller, manual gear operator with handle wheel for valve 5" and larger. Walworth No. 1797F or equivalent.
- E. Valves 2-1/2" and larger:
 - 1. Butterfly valve, full lug pattern, as specified herein.
 - 2. Furnish level handle with infinite throttling positions and locking device for securing handle in any position for valves 4" and smaller and manual gear operator with hand wheel for valves 5" and larger.

2.5 MANUAL AIR VENTS AND DRAIN VALVES

- A. For manual air vents and drain valves, see Specification Section 23 05 05, Piping Specialties.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All valves shall be installed in locations which will allow easy operation and facilitate maintenance.

END OF SECTION 23 0523

SECTION 23 0550
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, the Special Conditions, and General Requirements.

1.2 RELATED SECTIONS

- A. Section 23 05 00 for Common Work Requirements for HVAC.
- B. Section 23 05 93 for Testing, Adjusting and Balancing.
- C. Section 23 0800 Commissioning for MEP Systems

1.3 GENERAL

- A. Variable frequency drives shall be coordinated with the equipment being furnished and the wiring coordinated with the Division 26 contractor.
- B. Do not connect power factor correction devices in the electrical circuit serving any variable frequency drive or the motor downstream of the drive.
- C. Manufacturer's Qualifications: Firms regularly engaged in manufacture of variable speed ac motor drives of types and ratings required, whose products have been in satisfactory use in similar service for not less than five years. All Division 23 variable frequency drives shall be of one manufacturer/model series and be provided by the exclusive local representative for sole source responsibility of all aspects of sales, startup, service, training and warranty.
- D. Variable frequency drives shall be manufactured by Asea Brown Boveri (ABB), Series ACH 550.

1.4 SUBMITTALS

- A. Refer to Sections 23 05 00 for additional requirements.
- B. Product Data: Submit manufacturer's data including catalog information, performance data efficiency, harmonic distortion, RFI/EMI (Radio Frequency Interference/Electromagnetic Interference) specifications, installation instructions and general recommendations for each type or size of motor.
- C. The VFD manufacturer shall provide calculations as part of the shop drawing submittal specific to this installation showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by manufacturer to ensure compliance with IEEE Standard 519-1992, "Guide for Harmonic Control and Reactive Compensation for Static Power Converters."
- D. Shop Drawings: Submit dimensioned drawings of cabinet and front panel layout, showing

accurately scaled switches, their layouts and proximity to associated equipment. Furnish control schematic connection diagram showing all field connections.

1.5 SCOPE

- A. Furnish and install pulse width modulating (pwm) output wave HVAC Variable Frequency Drives (VFD) and control wiring between the VFD control system as specified in Section 23 05 50.
- B. The Variable Frequency AC Motor Drive shall be designed to convert the design volt with a tolerated voltage window $\pm 30\%$, 3 phase, 60 Hz input power to 0 to design volt, 3 phase, 0-60 Hz variable frequency output power. The output frequency and voltage of the drive shall be variable such that a constant volts/Hz ratio is maintained throughout the operating range. The volts/Hz ratio shall be adjustable.
- C. The drive shall be capable of operating any standard "off-the-shelf," NEMA B Design, squirrel cage induction motor with a 1.15 SF. The full load amp rating of the drive adjusted as required for jobsite elevation and ambient conditions shall be not less than 5% greater than the FLA rating of the motor or VFD must be oversized.
- D. For maintenance purposes, the drive shall be capable of starting, stopping, and running with stable operation with the motor completely disconnected (no load).
- E. Equipment will be designed and manufactured in accordance with applicable current NEMA, IEEE Standard 519-1992, (IEEE Guide for Harmonic Content and Control), UL 508, IEC 60730-1 Enclosures for Industrial Controls and Systems, and IEC 801-2, 801-4, 255-4 recommendations and be designed for installation per NEC. Equipment will have UL, CUL, or ETL Listing or CSA listing as approved and accepted by the state and local code authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

- A. Each VFD shall be of the pulse width modulating design and shall consist of:
 - 1. A full-wave diode bridge rectifier to convert incoming fixed voltage/frequency to a controlled DC voltage.
 - 2. A DC bus filter with a power factor of .95 or better over the entire speed range.
 - 3. The drive efficiency shall be 97% or better at full speed and full load. Efficiency shall not be less than 80% at 50% speed and load.
 - 4. An inverter section to change the controlled DC voltage to a PWM adjustable voltage/frequency output for complete motor speed control. The inverter output will be generated by power transistors which will be controlled by six identical base driver circuits.
- B. The VFD shall include the following:
 - 1. The unit enclosure shall be NEMA 1. Any VFD's mounted inside an equipment room with unducted return air and/or mounted in AHU (air handling unit) shall be furnished with NEMA type enclosure required by the local Construction Codes.

- All VFD's shall be UL Listed as plenum rated.
2. Electronic switching components shall be insulated gate/bipolar transistors, (IGBT).
 3. An externally operated, door interlocked, fused disconnect switch or circuit breaker shall be provided. The base VFD shall be UL Listed with a short circuit interrupting rating of 100,000 symmetrical amps minimum without the need for input fuses. The DC Buss output shall be fused separately or electronically protected, with an indicating pilot light.
 4. An internal 115V AC control power circuit with transformer and protective fuses shall be included or 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others.
 5. Provide solid state relay interface for remote start/stop in both VFD and bypass mode independent of safety circuits.
 6. Low frequency/low voltage start with linear adjustable ramp up to pre-selected speed.
 7. Controlled acceleration and deceleration, separately adjustable, shall be provided from 2 to 180 seconds with torque limit override acceleration protection, and regeneration protection.
 8. Critical Frequency lock out to skip over frequencies that may cause unstable operation in equipment being controlled. Provide at least three separate lockout settings.
 9. The VFD 'run permissive circuit' will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a system ready command/contact closure.
 10. Furnish line reactors/inductors with minimum 5% impedance designed to provide proper protection of harmonics and transients for the drive input power line. This is a minimum requirement, and the manufacturer shall furnish higher rated line reactors or isolation transformers as may be necessary to maintain specified maximum total harmonic voltage distortion. Line reactors/transformers shall be factory mounted and wired within VFD enclosure. The 5% impedance reactors may be from dual (positive and negative DC bus) reactors, or 5% impedance AC line reactors. VFD's with only one 5% DC reactor shall add AC line reactors.
 11. All components must be accessible from the cabinet door for service. The control shall be microprocessor based and the control card shall be the same part number and fully interchangeable for all ratings and voltages of VFD's.
 12. Drive must be designed for against the wall and/or floor mounted arrangements, as required by the project installation requirements.
 13. The drive shall be software programmed to provide automatic restart after a power outage or trip from overcurrent, over voltage, under voltage or over temperature. A delay shall occur before restart to allow motor to stop completely. The drive shall shut down and shall require manual restart if the automatic reset/restart function is not successful within 3-5 attempts within a short time period.
 14. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start). The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed.
 15. The VFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no

- inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.
16. Furnish terminal strip for external interlocks, isolated from the line and ground.
 17. Furnish prewired keypad with 3-position HAND-OFF-AUTO switches/buttons and manual speed control that will incorporate "bumpless transfer" of speed reference when switching between "HAND" and "AUTO" modes. When in "HAND," the VFD will be started, and the speed will be controlled from the manual speed control. When in "OFF," the VFD will be stopped. When in "AUTO," the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference.
 18. The drive shall employ three (3) current limit circuits to provide trip-free operation:
 - a. The Slow Current Regulation limit circuit shall be adjustable to 125% (minimum) of the VFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
 - b. The Rapid Current Regulation limit shall be adjustable to 170% (minimum) of the VFD's variable torque current rating.
 - c. The Current Switch-Off limit shall be fixed at 255% (minimum, instantaneous) of the VFD's variable torque current rating.
 19. The overload rating of the drive shall be 110% of its variable torque current rating for one (1) minute every 10 minutes, and 140% of its "H" torque current rating for two (2) seconds every 15 seconds.
 20. The VFD shall have door interlocked thermal magnetic circuit breaker which will disconnect all input power from drive and all internally mounted options when bypass is required. The disconnect handle shall be thru-the-door type and be pad-lockable in the OFF position.
 21. The VFD shall have input line fuses mounted in drive enclosure.
 22. The VFD shall be optimized for a 3 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up engineer. VFD shall reduce the carrier frequency based on actual VFD temperature that allows the highest carrier frequency without derating the VFD.
- C. The VFD shall have a programmable digital operator's keypad located in the front door of the drive enclosure which shall include the following features and requirements.
1. All VFD's shall have the same customer interface, including digital display, keypad and customer connections, regardless of horsepower rating. The keypad is to be used for local control (START/STOP, FORWARD/REVERSE, and speed adjust), for setting all parameters, and for stepping through the displays and menus.
 2. The VFD shall give the user the option of either 1) displaying a fault, or 2) running at a programmable preset speed or last speed known if the input reference (4-20 mA or 2-10V) is lost as selected by the user.
 3. The VFD's shall utilize plain English digital display (code numbers are not acceptable). The digital display shall be a 40-character (2-line x 20 characters/line) LCD display. The LCD shall be backlit to provide easy viewing in any light condition. The contrast should be adjustable to optimize viewing at any angle. All set-up parameters, indications, faults, warnings, and other information must be displayed in words to allow the user to understand what is being displayed without

- the use of a manual or cross-reference table.
4. There shall be a built-in time clock used to date and time stamp faults and record operating parameters at the time of fault. The clock shall also be programmable to control start/stop functions, constant speeds and four (4) separate, independent timer functions that have both weekday and weekend settings.
 5. The VFD's shall utilize pre-programmed application macros specifically designed to facilitate start-up. The digital keypad shall be removable, capable of remote mounting and uploading/downloading parameters and HVAC specific Application Macros that shall provide one (1) command to reprogram all parameters and customer interfaces for a particular application to reduce programming time and initial start-up of multiple VFD's.
 6. The VFD shall have a manual speed control integral to the keypad.
 7. VFD shall have RS-485 port. The standard protocols shall be Modbus RTU, Johnson Controls N2 bus, Siemens Building Technologies FLN and BACnet available. No additional hardware, firmware, gateways, etc., shall be required for these standard protocols. Optional protocols for Lon Works, Profibus, Ethernet, and DeviceNet shall be available, and have the protocol in each VFD. The use of third-party gateways and multiplexers is not acceptable.
 8. All protocols shall be "certified" by the governing authority, non-certified protocols are not allowed. If additional gateway, hardware, etc., is required to obtain the BACnet, Modbus, etc., interfaces, the VFD manufacturer shall supply one (1) gateway, hardware device, etc., per VFD. Multiple VFD's sharing one (1) gateway, hardware, etc., shall not be acceptable.
 9. BACnet connection shall be an RS485, MSTP 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 (BACnet Interoperability Building Blocks) defined by the BACnet standard profile for a B-ASC.
 10. All wires to be individually numbered at both ends for ease of troubleshooting.
- D. The following operation information displays shall be standard on the VFD digital display. The display shall be complete English words (alpha-numeric codes are not acceptable):
1. Output Frequency
 2. Motor Current
 3. Calculated Motor Torque
 4. Calculated Motor Power
 5. DC Bus Voltage
 6. Output Voltage
 7. Heatsink Temperature
 8. Analog Input Values
 9. Keypad Reference Values
 10. Elapsed Time Meter
 11. kWh Meter
- E. The drive shall have the following field adjustments:
1. Five (5) programmable critical frequency lockout ranges to prevent the VFD from continuously operating an unstable speed.
 2. PID setpoint controller shall be standard in the drive, allowing a pressure or flow. signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. There shall be an independent, second PID loop that can be

utilized to maintain setpoint of an independent process (i.e. valves, dampers, cooling tower bypass valve control, chilled water valve control, etc.

3. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 mA and 0 - 10 volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.
4. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices.
5. Two (2) programmable analog outputs proportional to frequency, motor speed, output voltage, output current, motor torque, motor power, DC bus voltage, or active reference.
6. Three (3) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; maximum voltage 30 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs must be true form "C" type contacts; open collector outputs are not acceptable.
7. Two (2) independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
8. Two (2) independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
9. The VFD shall ramp or coast to a STOP, as selected by the user.

F. Speed Command Input shall be via:

1. Keypad or manual speed control as selected by user.
2. Two (2) analog inputs, each capable of accepting a 0-20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.
3. Analog inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The analog input should be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0-20mA and 0-10 volts.
4. Floating point input shall accept a three-wire input from a Dwyer Photohelic, or equivalent type instrument.

2.2 USER SELECTABLE AUTOMATIC/MANUAL BY-PASS (Operation of motor at full voltage at 60 Hz fixed speed).

- A. Input line fused disconnect (service switch) and/or fast acting fuses exclusive to the VFD will allow the VFD to be disconnected from the line prior to clearing upstream branch circuit protection to maintain bypass capability. Door inter-locked, pad-lockable circuit breaker will disconnect all input power from the drive and all internally mounted options, together with fully rated magnetic motor starters mechanically interlocked shall be used to transfer motor to line power. Transfer must occur in orderly fashion causing no component damage to either drive or motor. Manual bypass circuitry must be integral part of drive.

cabinet. Separate bypass or starter enclosure is not acceptable. The VFD shall be UL

Listed by the drive manufacturer and UL508 label complete bypass assembly.

1. An output contactor, bypass contactor and VFD only disconnect/service switch and/or fuses will be provided. Overload protection shall be provided in both drive and bypass modes.
 2. Bypass designs that incorporate fuses common to both the VFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable, as a VFD input contactor is not a NEC recognized, lockable, physical disconnect and is an unacceptable means of safely disconnecting power to VFD.
 3. The drive / bypass shall provide single-phase motor protection and under-voltage protection of bypass, contactor coils, etc., shall be in both the VFD and bypass modes.
 4. The following operators shall be provided:
 - a. Bypass HAND-OFF-AUTO
 - b. Drive mode selector
 5. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation: One mode forces the motor to bypass operation. The second mode as above also defeats all safeties and inputs (run until destruction).
- B. Furnish auxiliary contacts to monitor drive status with FMS. A drive failure of any kind shall produce alarm signal and FMS.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The drive shall be installed in strict accordance with manufacturer instructions. A minimum of 42" clearance shall be maintained in front of drives.

3.2 EQUIPMENT PROTECTION

- A. Whenever possible drive shall be mounted within sight of motor that is controlled by drive. In the event that drive is not mounted within sight of motor, a disconnect will be installed (under Division 26) within sight of motor. If a disconnect is installed between motor and drive the drive supplier shall provide a 6" x 6" red engraved warning sign to be mounted at

"WARNING: TO AVOID DAMAGE TO FREQUENCY DRIVE DO NOT PULL DISCONNECT, EXCEPT IN AN EMERGENCY, UNTIL FREQUENCY DRIVE IS SHUTDOWN."

the disconnect which shall read as follows:

- B. Drive shall include a coordinated AC transient protection system consisting of MOV's (Metal Oxide Varistors: phase-to-phase and phase-to-ground), a capacitor clamp, and 5% impedance reactors designed to protect itself against all normal transients and surges in the incoming power line, any grounding or disconnecting of its output power, and any interruption or run away of the incoming speed reference signal. Protection is defined as a normal shutdown with no component damage.

- C. In general, the drive shall contain the following protective circuits. In the case of a
VARIABLE FREQUENCY DRIVES
ISSUE FOR CONSTRUCTION

protective trip, the drive shall STOP, and announce the fault condition in complete words (alpha-numeric codes are not acceptable).

1. Overcurrent trip 200% of the VFD's variable torque current rating.
2. Overvoltage trip 130% of the VFD's rated voltage.
3. Undervoltage trip 60% of the VFD's rated voltage.
4. Ground Fault.
5. Adaptable Electronic Motor Overload (I^2t). The electronic motor overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits which protect the motor only at full speed are unacceptable.

3.3 OPERATING CONDITIONS

- A. +/- 10%-line voltage variations.
- B. 5% incoming line frequency variations.
- C. Maximum output frequency variations shall be +/- .25%.
- D. FLA to meet or exceed UL/NEC table 430-150 of the minimum motor horsepower specified on the equipment schedule on the drawings.
- E. Ambient temperature.
 1. 0 to 50°C - NEMA 1 and 12 indoor enclosures: 1 thru 50 HP, 480 and 230 volts shall be capable of continuous operation as per VFD manufacturers documented/submittal data or VFD must be oversized.
 2. 0 to 40°C - NEMA 1 and 12 indoor enclosures: 60 thru 550 HP, 480 and 230 volts, shall be capable of continuous operation; from 49 to 50 Deg. C (104 to 122 Deg. F.), VFD current de-rate as per VFD manufacturers documented/submittal data or VFD must be oversized.
 3. 0 to 50°C - NEMA 3R outdoor enclosures inclusive of all HP and voltages shall be capable of continuous operation as per VFD manufacturers documented/submittal data or VFD must be oversized.
- F. 90% Maximum humidity (non-condensing).

3.4 TESTING AND DOCUMENTATION

- A. Manufacturer to conduct standard factory tests to assure compliance with specification requirements.
- B. Manufacturer's local Designated Service Station's startup technician shall provide field startup and commission of all VFD's and shall demonstrate trouble free, stable operation for conditions of starting, full load, three quarter load, half load, quarter load, no load and intermediate loads. The local Designated Service Station shall have factory trained and certified applications engineer/service personnel to provide service, training and warranty onsite 24/365 (24 hours / 365 days per year) and a toll-free support line. Provide four (4) hours onsite training of programming and operation.
- C. Field tests shall include 100 hours of operation under load to demonstrate adequacy of equipment under thermal and voltage stresses, and that harmonic and other interferences do not adversely affect the electrical instrumentation and communications systems.

- D. Manufacturers technically qualified and factory trained representative to make final written documents of installation, inspection, and test run.
- E. Field testing to include demonstration of automatic restart under operation of the following existing controls:
 - 1. Fire Alarm.
 - 2. OFF/AUTO Switch.
 - 3. Clock Control.
 - 4. FMS START/STOP in both VFD and BYPASS MODE.
- F. Switching from bypass to VFD operation both manually and automatically which shall be user selectable.
- G. Complete records of test procedure and results to be made available at no additional cost to purchaser's representative.
- H. Equipment shall carry a two (2) year guarantee as to workmanship, material, and satisfactory functioning from date of startup or maximum of 30 months from date of shipment from factory.
- I. Furnish complete sets of their drawings showing control schematics, transistor schematics, wiring, outline dimensions, mounting details and equipment weight.
- J. Operating & Maintenance Data and Spare Parts List - Furnish copies of all instruction books, spare parts lists and special bulletins covering on-site installation and operation in accordance with Section 23 0500.

END OF SECTION 23 0550

SECTION 23 0593
TESTING, ADJUSTING AND BALANCING OF MECH. SYSTEMS

PART 1 - GENERAL

1.1 GENERAL

- A. Conform with applicable provisions of the General Provisions and the General Requirements.
- B. Testing, adjusting, and balancing (TAB) shall be performed by a TAB Agency which is independent of the Mechanical Contractor.
- C. Testing, adjusting and balancing (TAB) shall be performed by a TAB Agency which is not performing commissioning for this project.
- D. The TAB Agency's efforts shall be paid for by the contractor and included in the mechanical contract price.
- E. Unless specifically noted, all work specified in this section shall be included in the scope of the TAB Agency's work. But some work described in this section is to be performed by the mechanical contractor, controls contractor, or others, and that work is specifically noted to be by these entities.

1.2 SCOPE

- A. Provide TAB for the systems and equipment installed under Division 23, including but not limited to:
 - 1. Hydronic systems.
- B. Provide all labor, instruments, and tools necessary to test, adjust and balance the systems shown on the drawings and/or described in these specifications. Check equipment performance, take measurements, adjust systems and equipment to provide specified performance, and report results. Submit reports to keep all parties posted on the progress of the TAB work.
- C. Where the TAB effort indicates deficiencies in system performance, participate in a collaborative effort to resolve these deficiencies. Engage the assistance of others where necessary, starting with the Mechanical Contractor and Controls Subcontractor. Take additional measurements as required to identify the cause of the deficiencies. Engage the assistance of the Engineer and others where necessary.

1.3 STANDARDS AND DEFINITIONS

- A. Perform all work in accordance with these specifications and the latest edition of the NEBB Standards.
- B. Hydronic System: A system in which a liquid is used to convey heat.
- C. Record or Report: Where used as a verb, these terms mean to include in the TAB report.

1.4 QUALIFICATIONS

- A. TAB agencies shall meet the following qualifications:
 - 1. Membership in the Associated Air Balance Council (AABC), National Environmental Balance Bureau (NEBB) or the Testing, Adjusting and Balancing Bureau (TABB).
 - 2. A minimum of five (5) years' experience in the TAB field.

1.5 SUBMITTALS

- A. Mechanical Contractor shall submit the name of the proposed TAB agency prior to the TAB agency performing any services.
 - 1. Submit a list of proposed personnel, including resumes with related project experience and certifications.
 - 2. Submit proposed TAB procedures, instrumentation and measurement equipment including calibration data, and proposed sample TAB report forms.
- B. Pre-Construction Report: Prior to the Mechanical Contractor installing the systems, the TAB Agency shall submit a letter indicating whether the design includes all devices the TAB Agency will need to successfully perform the TAB work. If any additional balancing devices are needed, the TAB Agency shall so note this in the pre-construction report.
- C. Submit TAB reports as noted herein. Reports shall be in both hard copy and PDF format.

1.6 TAB PREPARATION AND COORDINATION

- A. Mechanical Contractor shall perform the following in a timely fashion:
 - 1. Provide the TAB Agency with the project documentation (drawings, specifications, bulletins, submittals, shop drawings, etc.) necessary to perform the TAB services.
 - 2. Install, fill, pressure test, start up, clean, and the vent systems to be tested and balanced.
- B. Controls Subcontractor shall perform the following in a timely fashion:
 - 1. Install and make operational all necessary control systems and equipment, including computers and computer programs.
 - 2. Provide qualified personnel to operate the systems as necessary to support the TAB effort. Provide the TAB contractor with the computer software necessary to facilitate the TAB effort.
 - 3. Assist as required to resolve problems which become evident due to TAB work, and as required to obtain specified system performance.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Provide all equipment and instruments necessary to perform the work specified herein.

Calibrate and maintain instruments per NEBB Standards. Provide not less than the following:

1. Pitot tubes and draft gauges
2. Flow hood
3. Velometer
4. Thermometers
5. Pressure gauges
6. Flow meter test kit
7. Ampere – voltmeter
8. Speed indicator

PART 3 - EXECUTION

3.1 GENERAL

- A. Review and inspect the mechanical systems for conformance with design documents. Test, adjust and balance all system flows under design conditions and under other conditions where part load testing is specified. Comply with measurement tolerances per NEBB. Balance to within 10% of design flows unless otherwise specified.
- B. Visually mark the final settings of balancing dampers, balancing valves, fan speed controls, etc.
- C. Comply with NEBB Standards. The descriptions included herein are a guide to the minimum information needed.
- D. Troubleshooting: In the event that any areas fail to get proper flow, assist in troubleshooting the system. Measure pressures at various points throughout the systems as required locating the cause of the deficiencies and assisting in identifying upgrades which will resolve these deficiencies.

3.2 TEST AND BALANCE REPORT

- A. Include a cover sheet with the project name and the names of the Mechanical Contractor and Engineer, table of contents, summary indicating the highlights of the report and summarizing any deficiencies and recommendations, summary of the test procedures used, names of the persons performing the tests, dates the tests were performed, list of instruments used along with their calibration data, and data sheets and drawings as indicated below.
- B. Report shall be 8-1/2" x 11" bound into a complete and coherent report, except those drawings may be larger size, but still bound into the report. All forms shall be typewritten or legibly handwritten.
- C. Submit a PDF of the complete TAB report minimum two weeks before the first O&M instruction session.

3.3 HYDRONIC SYSTEMS

- A. General:

1. Prior to commencing hydronic balance:
 - a. Set valves to proper position per the sequence of operation. Open all coil valves to fully open position.
 - b. Check pump rotation.
 - c. Verify that system is adequately pressurized.
 - d. Set temperature controls so all system components deliver maximum flow.
 - e. Balancing may be done in sections.
2. Pumping Systems: Measure flows and determine operating characteristics of hydronic systems with pumps operating independently. Make measurements at maximum flow.
3. Balance systems to minimize throttling out in the distribution, and to instead throttle at the pump discharge. Recommend impeller trimming if appropriate.
4. Measure and report performance readings on all pumps, coils, heat exchangers, heating and cooling water generating equipment, flow measurement devices, heat rejection equipment, etc.

END OF SECTION 23 0593

SECTION 23 0700
MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

- A. Section 23 05 00, Common Work Requirements for HVAC.
- B. Section 23 05 04, Pipe and Pipe Fittings.
- C. Section 23 30 00, Air Tempering System and Equipment.

1.3 SCOPE

- A. Field insulation of piping.
- B. Field insulation of equipment supplied and/or installed under Division 23: See Part 3 of this specification.
- C. Factory-insulated equipment and materials are described on the equipment schedule, on the drawings, and in other sections of this specification.

1.4 SUBMITTALS

- A. Submit products to be used including insulation, jackets, miscellaneous products, and products for special applications. Review each application and advise if any product is either not suitable for, or not recommended for the application.
- B. Verify that each submitted product meets all requirements for that product as specified herein. Include literature that clearly shows products meet all aspects of the spec. Include a cover sheet or letter with the following statement:

"Each product submitted here meets all specified requirements for that product except as follows:" followed by a list of any discrepancies.
- C. Submit schedules showing the type of product and thickness for each application. Indicate products to be used on valves and fittings. Indicate where vapor barriers will be provided and what jackets will be used.
- D. D-5, D-6 & D-7 insulation: If one of these insulations is specified, submit documentation indicating that the submitted materials are approved for the intended service.

- E. Submit a description of the application techniques to be used.

1.5 QUALITY ASSURANCE

- A. Comply with the latest edition of the National Commercial & Industrial Insulation Standards.
- B. Part 3 and Table 23 07 00-1 give the system temperatures for various applications. Supplier shall review these temperatures and confirm the suitability of all components for the specified applications.
- C. Test piping and ductwork in accordance with applicable specification sections before insulation is applied.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials must be 100% asbestos-free.
- B. All materials must be Greengard Certified, Greengard Certified for Children and Schools.
- C. Smoke and Fire Ratings: All materials shall have a composite fire and smoke hazard rating not exceeding flame spread 25, fuel contribution 50, smoke developed 50, when tested as assemblies per ASTM Standard E-84 or NFPA 255.
- D. Thermal conductivities: Per ASTM C518. Do not exceed the conductivities indicated. Units listed herein for conductivity are Btuh-in/SF-F. Resistance shall not be less than the values specified herein. Units for resistance are SF-F/Btuh.
- E. Noise Reduction Coefficients: Per ASTM C423 based on Type A mounting. NRC shall not be less than as specified.
- F. Jackets: Maximum 0.02 perm water vapor transmission per ASTM E96 Procedure A.
 - 1. ASJ: All service jacket per ASTM C1136 Type I, paintable white kraft paper outer surface reinforced with glass fiber yarn and bonded to aluminum foil, with self-sealing longitudinal lap and butt strips, breach puncture min. 50 oz-in/in tear per ASTM D781, tensile strength min. 30 lb/in per ASTM D828.
 - 2. FSK: Foil skim kraft per ASTM C1136 Type II.
- G. Fiberglass insulation: Inorganic fibers bonded with thermosetting resin.
- H. Approved Manufacturers: Owens Corning, Johns Manville, Knauf, Kflex, Armacell, Unifrax -Insulfrax, Industrial Insulation Group, Pittsburgh Corning, AFS, ANCO, Thermaflex. Where the term OAE is used herein, this refers to these manufacturers only. No other manufacturers are approved for this project.

2.2 PIPE INSULATION

- A. General

1. Valves, Fittings, and Accessories: Use the same insulation materials and thickness as the pipe insulation, except as noted.
- B. Type P-1, Fiberglass Pipe Insulation: Factory assembled insulation and ASJ. Pre-formed fiberglass per ASTM C547 Type I, suitable for use on surfaces from 0–850°F, with thermal conductivity 0.23 at 75°F or 0.33 at 250°F, and minimum 3 pcf density. ASJ shall have self-sealing lap at end and along length, with pressure sensitive tape lap sealing system. Owens Corning SSL II Pipe Insulation, Johns Manville Micro-Lok, Knauf Pipe Insulation.
 1. Where Type P-1 insulation is used, insulate fittings, valves and accessories using one of the following:
 - a. Fiberglass pre-formed fitting insulation complying with the specification for P-1 pipe insulation, Johns Manville Hi-Lo Temp insulation inserts, Hamfab, OAE. Finish with Type J-2 fitting covers.
- C. Type P-2, Elastomeric Foam Pipe Insulation: Pre-formed elastomeric foam, ASTM C534 Type 1 flexible, closed cell, suitable for use up to 220°F, UV protected, not to exceed flame spread 25 and smoke developed 50 based on 0.75-inch thickness, conductivity 0.30 at 75°F. Kflex, Armacell OAE.
 1. Fittings, valves and accessories: Insulate using either Type P-2 insulation pre-formed for use on fittings and valves or cut sections of P-2 pipe insulation to match the shape of the fitting or valve, taped on using PVC tape.

2.3 DUCTWORK INSULATION

- A. Type D-1, Fiberglass Blanket: Factory fabricated insulation and FSK jacket assembly suitable for applications from 40-250°F, 3/4 pcf fiberglass, ASTM C553 Type I or II, with thermal resistance not less than the following for 2-inch thickness: 6.8 out of the box, 5.6 installed with 25% compression. Johns Manville Microlite XG Duct Wrap, Owens Corning Soft R Duct Wrap, Knauf Friendly Feel Duct Wrap, CertainTeed Soft Touch Duct Wrap.
- B. Type D-2, Fiberglass Board: Similar to Type D-1 except rigid board type, 3 pcf density, thermal conductivity 0.23 at 75°F, NRC 1.36, suitable for unfaced side at up to 450°F and faced side at up to 150°F. Johns Manville 800 Series Spin Glass, Owens Corning 700 Series Board, Knauf Insulation Board, CertainTeed Certra Pro Commercial Board
- C. Type D-3, Acoustic Lining (roll type): Organic fiber or fiberglass duct liner bonded with thermosetting resin, with factory-applied acrylic surface coating treated with anti-microbial agent, and factory-applied or shop-applied edge coating.
 1. Properties: Minimum 1.5 pcf density, thermal conductivity 0.24, 6000 FPM rated per UL 181, NRC 0.70 at 1-inch thick and .95 at 2-inch thick. The product (fiberglass, resin, coating, microbial agent and adhesive) as an assembly shall be suitable for surfaces and gases up to 250°F and shall comply with ASTM C1071 (Type I), G21 and G22.
 2. Lining surface shall be cleanable using commercially available duct cleaning

- equipment when performed by qualified technicians using procedures established and recommended by the North American Insulation Manufacturer's Association (NAIMA) Duct Cleaning Guide.
3. Johns Manville Linacoustic RC, Owens Corning Acoustic R duct liner, Knauf EM duct liner, CertainTeed Tough Guard R Duct Liner.
- D. Type D-4, Acoustic Duct Liner (roll type): Elastomeric thermal and acoustical duct liner made with EPA registered antimicrobial product protection.
1. Properties: Minimum 1" thick, thermal conductivity 0.25, 6000 FPM rated per UL 181, NRC 0.70 at 1-inch thick and .95 at 2-inch thick. The product (foam, coating, microbial agent and adhesive, etc.) as an assembly shall be suitable for surfaces and gases up to 180°F, and shall comply with ASTM C 1534, ASTM E84, NFPA 90A, 90B and 255. Rated flame spread and smoke develop index shall be 25/50 or better.
 2. Lining surface shall be cleanable using commercially available duct cleaning equipment when performed by qualified technicians using procedures established and recommended by the North American Insulation Manufacturer's Association (NAIMA) Duct Cleaning Guide.
 3. Armacell AP Coilflex, K-Flex Duct Liner Gray, or approved equal.
- E. Type D-5 – Fiberglass Duct board: Listed per UL 181 as a Class 1 Rigid Air Duct; conforming to ASHRAE Std. 62, NFPA-90A and 90B, ASTM G-21 & G-22; rated for 2-in. wg; constructed of fiberglass bonded with a thermosetting resin, with double density slip joints pre-molded in the board; FSK jacket; thermosetting acrylic polymer interior surface, and black interior surface color. Thermal conductivity 0.23, and NRC 0.70 at 1-inch thick and 1.0 at 2-inch thick. Johns Manville Super duct 475 or 800, Owens Corning Quiet R Duct Board, Knauf Duct Board M, CertainTeed Tough Gard Duct Board

2.4 CHILLED WATER PUMP INSULATION

- A. E-1, Elastomeric 2" thermal insulation to avoid condensation.

2.5 INSULATION JACKETS

- A. Type J-1, Metal Jacket: 0.010-inch smooth Type 304 stainless steel or 0.016-inch smooth or embossed aluminum per ASTM B-209, with minimum 1-mil polyethylene film with protective layer of 40 Lb. virgin kraft paper, continuously laminated to full width inside jacket. Childers OAE.
1. Where jacket diameter is 16–96 in: 0.016-in. SS or 0.020 in. aluminum.
 2. Equipment heads and all surfaces where jacket is greater than 96-inch OD: 0.020-inch SS or 0.024-inch aluminum.
 3. Fittings and Accessories: Provide the same jacket material as for pipe.
- B. Type J-2, PVC Jacket: Minimum 20 mil sheets and 30-mil pre-molded fitting covers, ASTM D1784, Class 16354-C. Accessories include solvent weld solution, stainless steel tacks, and tape. All components shall be white, UV resistant, with paintable exterior surface, and suitable for use at –20 to +150°F. Johns Manville System 2000 (sheets), Zeston 300 (fitting covers), and Perma-Weld (solvent cement), OAE.
- C. Type J-3, Canvas Jacket: 10 x 10 fiberglass mesh.

2.6 MISCELLANEOUS PRODUCTS

- A. General:
 - 1. Tapes: Aluminum foil backed tape on ducts is not permitted. Use fiberglass and Benjamin Foster duct sealant with fiberglass mat embedded in sealant.
 - 2. Duct Liner Adhesives: Water-based, complying with ASTM C916.
 - 3. Solvent Cement for PVC Jackets: Johns Manville Perma-Weld OAE.
 - 4. Staples: Outward clinching, 0.5-inch galvanized steel
- B. Piping Systems:
 - 1. Pipe Hanger Insulation Inserts: Mechanical Pipe Shields Inc. "Snapp Itz" OAE.
- C. Ductwork Systems:
 - 1. Duct Liner Edge Sealer, Surface Sealer, Coatings & Adhesives: To meet ASTM C916. Johns Manville Super seal OAE.

PART 3 - EXECUTION

3.1 GENERAL

- A. Delivery, Storage and Handling: Deliver and store insulation materials in factory-supplied containers. Protect from moisture. Do not install any materials that have gotten wet, regardless of whether they are subsequently dried.
- B. Store and apply materials in accordance with manufacturers' recommendations, but not less than the following minimum temperatures. Ensure surfaces are clean and dry prior to application, and for minimum two hours after application:
 - 1. Sealers, coatings, solvents and adhesives: 40°F.
 - 2. Tapes 50°F.
- C. Install in accordance with manufacturer's recommendations, NAIMA recommendations, and this spec. Provide good ventilation.
- D. Where vapor barriers are specified, ensure that the entire system is vapor sealed.
- E. Protect materials from water damage. Replace any materials that are water-damaged prior to substantial completion.

3.2 PIPING INSULATION

- A. General: Insulate piping as indicated herein and on the drawings. Except as noted, insulate all valves, fittings, and accessories with the same material and thickness specified for the pipe. Where piping is specified with a separate insulation jacket provide this same jacket for valves, fittings, and accessories. Vapor seal cold piping systems.
 - 1. Where insulation terminates, provide insulating cement beveled for a neat finish. For vapor sealed piping, coat with insulating mastic prior to applying insulating cement.
 - 2. Strainers and Suction Diffusers: Type P-1. Make provisions to easily remove and re-install insulation.

3. Pipe Supports: Provide high density calcium silicate insulation or insulation inserts as specified. Maintain pipe jacket and vapor barrier at supports. If necessary, apply a heavy coating of vapor barrier mastic material to prevent condensation from forming on supports. Provide galvanized steel insulation shields to protect insulation and jackets at supports.
4. Penetrations Through Building Construction: Insulation shall be continuous where piping passes through walls, floors, and other construction. Where insulated piping passes through fire and/or smoke rated construction, provide a section of UL approved fire safing insulation to match the required insulation thickness, or provide an insulated pipe sleeve as manufactured by Pipe Shield, Inc., OAE.
5. Mechanical Couplings: Where mechanical couplings are permitted, insulate them as specified for fittings.
6. Steam Traps: Do not insulate.
7. Retrofit Projects: Match the thickness of existing insulation where new insulation adjoins existing. Integrate new vapor barrier with existing so the insulation barrier is continuous for both new and existing piping.
8. All voids formed by support saddles or other mounting, or support hardware shall be filled with insulation.

Application:

Temp Range	Temp (F)	Insulation Type	Vapor Sealed	Pipe Size (inch dia.)				
				Under 1	1 & 1.25	1.5 - 3	4 & 6	8 & Larger
				Insulation Thickness (inches)				
TR-1	60 & Less	P-2	Yes	0.5	1.0	1.5	2	2
TR-2	61 - 104	P-2	Yes	0.5	0.5	0.5	0.5	0.5
TR-3	105 - 140	P-1	No	0.5	0.5	1.0	1.0	1.0
TR-4	141 - 200	P-1	No	1.0	1.0	1.0	1.5	1.5
TR-5	201 - 250	P-1	No	1.5	1.5	2.0	2.0	2.0
TR-6	251 - 350	P-1	No	1.5	2.5	3.0	3.0	3.0
TR-7	Over 350	P-1	No	2.5	3.0	3.0	4.0	4.0

Temperature Range TR-1: Chilled water, condensate drains indoors.

Temperature Range TR-2: Domestic cold water.

Temperature Range TR-3: Domestic hot water.

Temperature Range TR-4: Heating water supply and return.

Temperature Range TR-5: Not Applicable to this project.

Temperature Range TR-6: Not Applicable to this project.

Temperature Range TR-7: Not Applicable to this project.

B. Special Applications

1. Heat Traced Piping: Oversize insulation as required to accommodate heat tracing. Provide metal jacket.
2. Plastic pipe in return air plenums: Provide 0.5-inch type D6 insulation.
3. Piping subject to freezing and heat traced piping: Insulate all such piping (including drain piping) with thicknesses specified, but not less than 2-inch thickness. Oversize insulation to accommodate heat tracing where applicable. Provide J1 jacket.

- C. Type P-1, Fiberglass Insulation: Install in accordance with manufacturer's recommendations.
- D. Calcium Silicate Insulation: Adhere to pipe or equipment using stainless steel wire. Provide removable J-1 jacket.
- E. Type P-2, Elastomeric Foam: Seal all butt ends and longitudinal joints with Halstead Adhesive. When exposed to the weather, protect flexible tubing insulation with two coats of exterior weatherproof coating as recommended by manufacturer.
- F. Jacketing: In addition to the finish and jacket specified for the particular type of insulation, provide the following:
 - 1. Indoor exposed piping Type J-1, Metal
 - 2. Mechanical Equipment Spaces: Exposed piping
less than 8 ft above floor or operator platform Type J-1, Metal
 - 3. Exterior piping Type J-1, Metal

3.3 DUCTWORK INSULATION

- A. General:
 - 1. Insulate all ducts except those specified to be uninsulated. The following ductwork need not be field insulated:
 - a. Factory insulated ductwork and plenums.
 - 2. See Table 23 07 00-1 for additional information.
 - 3. Ensure that ductwork is leakage tested prior to applying insulation. Inspect ductwork and repair any deficiencies prior to applying insulation. Do not apply insulation over deficient ductwork or plenum construction.
 - 4. Ensure that ductwork is clean and dry before applying insulation.
- B. Type D-1, Fiberglass Blanket Insulation: Measure and cut insulation. Install so insulation is not excessively compressed at corners. For rectangular and flat oval ducts 24-inches and wider, provide stick pins and speed clip washers 18-inches on centers on the bottom, and clip off excess length of stick. Firmly butt insulation ends and longitudinal joints. Overlap jacket minimum 2-inches at end joints and longitudinal joints, staple on 6-inch centers, and continuously seal jacket. Provide vapor barrier mastic where ducts are indicated to be vapor sealed. Should gaps or fish mouths occur, re-staple and seal them with mastic. Use FSK tape and vapor barrier mastic to seal all penetrations of the FSK jacket, such as pins, tears, and hangers. Neatly trim and seal insulation at access doors, ends, damper rod controls etc. Verify proper damper operation.
- C. Type D-2, Fiberglass Board Insulation: Attach with mechanical fasteners 12" on centers.
- D. Type D-3, Acoustic Lining: Ductwork dimensions indicated on the drawings are net air flow dimensions inside liner. Increase duct size to accommodate liner. Completely line the inside surfaces of ducts and plenums specified and indicated. Comply with the NAIMA Fibrous Glass Duct Liner Standard (FGDLS), manufacturer's recommendations, and this spec. Adhere liner with minimum 90% coverage of adhesive, and secure with mechanical fasteners and washers per FGDLS and manufacturer's recommendations. Fastener length shall be sufficient to limit compression of liner to 1/8" maximum. Coat all cut edges and surface penetrations with edge sealer. Provide metal nosing for liner leading edges at fan discharge and for all ducts with air velocities exceeding 3,000 FPM. Maintain minimum 18-inch clearance from electric resistance heaters. Interrupt liner at dampers and apply

external insulation at these locations.

- E. Type D-4, Acoustic Lining: Ductwork dimensions indicated on the drawings are net air flow dimensions inside liner. Increase duct size to accommodate liner. Completely line the inside surfaces of ducts and plenums specified and indicated. Comply with manufacturer's recommendations, and this spec. Adhere liner with minimum 90% coverage of adhesive, and secure with mechanical fasteners and washers per FGDLs and manufacturer's recommendations unless using self-adhesive product. Fastener length shall be sufficient to limit compression of liner to 1/8" maximum. Maintain minimum 18-inch clearance from electric resistance heaters. Interrupt liner at dampers and apply external insulation at these locations.
 - 1. Provide Type D-4 insulation for the 10 feet upstream of roof exhaust fans except in wet air streams.
 - 2. Provide Type D-4 acoustic lining for all exterior duct section upstream of rooftop unit in addition to specified jacketed exterior duct insulation.
- F. Type D-5: Install per manufacturer's recommendations, NAIMA standards, and SMACNA Fibrous Glass Duct Construction Standards. Provide ship lap seams and joints.
- G. Type D-6: Factory installed per manufacturer's recommendations in double wall duct system.

3.4 CHILLED WATER PUMP INSULATION

- A. General: Insulate following manufacturer's recommendations. Insulation shall not deny access to areas that will require access for service.

3.5 JACKETING

- A. Type J-1, Metal Jacketing:
 - 1. Ducts: Slope jacketing to shed rain.
 - 2. Pipes: Install with seams at the 3 o'clock or 9 o'clock position to shed water. Band 12" on centers.
 - 3. Joints and Seams: Overlap joints minimum 2-inches. Caulk with a weatherproof caulk when located outdoors.
- B. Type J-2, PVC Jacketing: Secure in place with tacks and solvent welded joints. White PVC tape may be used indoors.
- C. Type J-3, Canvas Jacket: Apply mastic at a rate of 60 to 70 sq. ft. per gallon, embed fiberglass mesh, smooth all wrinkles, and apply finish coat of Sealfas, or equivalent.

TABLE 23 07 00-1 – DUCTWORK INSULATION

Service	Location	Condition	Insulation Type	Insulation Thickness (in)	Notes
Supply Air, Makeup Air, Outside Air	Indoor	Concealed	D1	1.5	
Supply Air, Makeup Air, Outside Air	Indoor	Exposed	D1	1.5	1,2
Supply Rectangular Ductwork downstream of Terminal Units, AHU's	Indoor	All	D1	1.5	
Transfer Air Ducts	All	All	D3	1	
Exhaust Ductwork	Indoor	Concealed	D1	1.5	
Exhaust Ductwork	Indoor	Exposed	No insulation		2

Notes:

- 1 Provide factory fabricated double wall duct system. Refer to Double Wall information in Section 23 3000 Air Tempering Systems and Equipment.
- 2 Exposed condition refers to all conditioned interior areas without ceiling.

END OF SECTION 23 0700

SECTION 23 0800
COMMISSIONING OF MEP SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

- A. Provide commissioning work as specified herein. Contractor is responsible to self-perform or hire a third-party consultant to perform commissioning services as required by the International Energy Conservation Code (IECC) 2015. Commissioning services for this project shall include work in the new Weight Room Building.
- B. All commissioning work shall be in compliance with requirements from IECC 2015 Section C408 System Commissioning.

1.2 COMMISSIONING

- A. A complete checkout and test shall be performed to demonstrate and certify that HVAC equipment (including controls) are 100% operational and adjusted upon completion of the installation, and that they comply with design intent and project contract documents.
- B. The Commissioning Agent (CxA) shall prepare, provide, and document Pre-functional Checklists for the systems to be commissioned. Copies of all documentation shall be provided to the Owner.
- C. The Commissioning Agent (CxA) shall prepare, provide, and document Functional Tests for the systems to be commissioned. Copies of all documentation shall be provided to the Owner.
- D. All tests shall be witnessed and acknowledged by written signature of the General Contractor's supervising representative. The Owner's representative may elect to observe this first part testing.
- E. The General Contractor shall coordinate the test schedule with the Commissioning Agent, Electrical Contractor, Mechanical Contractor, and other Contractors required to be present for a complete and functional test.
- F. The system checkout and test shall be a comprehensive 100% inspection and functional test of all equipment and software and shall include, but not be limited to, the following:
 - 1. Testing to verify that all control functions specified in the sequence of operation are provided and fully functional as specified and required.
 - 2. Verification of manual and program control of all start/stop and alarm points, including status indication and alarms.
 - 3. Verification of all controlled points including setpoint and actual point readouts, remote setpoint change and point alarm.
 - 4. Verification that all system annunciation text and messages are correct and appropriate.
 - 5. Testing to verify that all specified software is provided and fully implemented.
 - 6. Display and demonstrate such data entry template and show site specific customizing capability. Demonstrate parameter changes.
 - 7. Other testing required by the Commissioning Agent's Specifications.
 - 8. Anticipated HVAC Systems to be commissioned include:
 - a. Controls: Sequence of Operation, Interlocks, Schedules.

- b. Equipment: Chillers, Chilled Water Pumps with VFDs and AHU chilled water control valve (Alternate #1), scheduling and controls.

G. The CxA shall develop a Commissioning Plan including:

- 1. A narrative description of the activities that will be accomplished during each phase of commissioning and the personnel intended to accomplish each of the activities.
- 2. A listing of the specific equipment or systems to be tested and a description of the tests to be performed.
- 3. Functions to be tested.
- 4. Conditions under which the test will be performed. Testing shall affirm winter and summer design conditions and full outside air conditions.

H. The CxA shall prepare and provide the Owner a Preliminary commissioning report to:

- 1. Itemize deficiencies found during the testing,
- 2. Identify deferred tests that could not be performed due to climatic conditions,
- 3. Identify climatic conditions required for performance of the deferred tests.

I. The CxA shall prepare and provide the Owner a Final commissioning report including the following information:

- 1. Results of functional tests,
- 2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed,
- 3. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance.

END OF SECTION 23 0800

SECTION 23 2114
CHILLED WATER SYSTEM AND EQUIPMENT

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.

1.2 RELATED SECTIONS

- A. Section 23 05 00 for Common Work Requirements for HVAC.
- B. Section 23 05 04 for Pipe and Pipe Fittings.
- C. Section 23 05 05 for Piping Specialties.
- D. Section 23 05 23 for Valves.
- E. Section 23 07 00 for Mechanical Systems Insulation.
- F. Section 25 0000 Instrumentation and Control HAVC.
- G. Division 26, Electrical.

PART 2 - PRODUCTS

2.1 PIPING

- A. Copper Piping – 4” and less- The Contractor may use Type L hard drawn copper tubing, ASTM B88 for chilled water piping. Proper insulating fittings shall be installed to prevent electrolytic action between steel and copper piping connections.
- B. Polypropylene pipe with multi-layer faser (SDR-11 MF), ASTM F2389 – All sizes. Pipe shall have certification from NSF to meet NSF 14 and 61 and shall be listed with ICC. Pipe minimum rating shall be 160 psi at 74 F degrees. The Contractor may use this product as a suitable substitute for copper 4” and smaller. Certified of flame spread/smoke development rating of 25/50 in accordance with ASTM E84 when wrapped with standard pipe insulation, field installed. Contractor (all installers) shall be trained by factory authorized representative prior to installation. Contractor shall coordinate expansion control requirements with manufacturer and install as required. Manufacturers Aquatherm Blue Pipe, Niron or approved equal.
- C. Carbon Steel - Above ground hydronic piping 4” and greater – Pipe shall comply with ASTM A53, Grade B Type E or S, standard weight black steel pipe.

2.2 FITTINGS

- A. Copper Pipe Fittings shall be wrought copper conforming to ANSI B16.22, with 95-5 solder joints, as specified in Section 23 05 04. Viega propress fittings only.
- B. Carbon steel Fitting shall comply with ASTM A234 WPB, ANSI B16.11 standard weight seamless. Victaulic grooved fittings are only acceptable at chiller nozzles.
- C. Mechanically formed tee connections and couplings for copper piping system shall be as specified in Section 23 05 04.

2.3 VALVES

- A. Valves other than automatic control valves shall be specified in Section 23 05 23, Valves.
- B. Automatic control valves shall be as specified in Section 25 00 00, Integrated Automation.

2.4 COILS

- A. Chilled water coils shall be as specified in Section 23 30 00, Air Tempering System and Equipment, Section 23 74 33, Air Handling Units and as listed on the Mechanical Equipment Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Piping installation shall conform to the requirements of Section 23 05 00, Common Work Requirements for HVAC, and Section 23 05 04, Pipe and Pipe Fittings. Installation of specialties shall conform to the requirements of Section 23 05 05, Piping Specialties.

3.2 CLEANING AND FLUSHING PIPING SYSTEMS

- A. New chilled water piping systems installed under this Contract shall be chemically cleaned of oils, greases, dirt and mill scale. The new piping system shall be inspected by the Owner's approved Water Treatment Agency.
- B. Cleaning shall be performed in strict accordance with the chemical treatment agency and manufacturer's recommendations.
- C. After the mechanical contractor has prepared the building and the piping to be flushed after it has been tested. Provide a complete water flushing and cleaning of the closed loop hot water systems as specified herein. Systems must be commissioned as clean and meet the water treatment specifications.
- D. All chilled water piping and related equipment shall be thoroughly flushed out with pre-cleaning chemicals designed to remove deposits such as pipe dope, oils, loose rust, mill

scale and other extraneous materials. Recommended dosages of pre-cleaner chemical products shall be furnished by water treatment supplier, added, and circulated throughout the water systems. The water systems shall then be drained, refilled, and flushed thoroughly until no foreign matter is observed and total alkalinity of the rinse water is equal to or better than that of the make-up water.

- E. All polypropylene piping and related equipment shall be thoroughly flushed out with high volume and velocity water designed to remove deposits such as pipe shavings, dirt, debris, and any other and other extraneous materials.
- F. All temporary connections required for cleaning, purging, and circulating shall be included. Provide suitable pipe bypasses at each coil and heat exchanger during this cleaning operation.
- G. Flushing & Cleaning – a third party flushing company should be used. Permanent facility pumps should not be used for circulating the cleaning water. However, if its impractical to use temporary pumps, the permanent facility pump may be used provided that the pump is unconditionally warranted for two years, parts and labor, after the date of substantial completion by the mechanical contractor. A documented flush plan may be required at the discretion of the engineer. All operators should be aware of and abide by the Safety and PPE regulations of the project site. Operation should be manned continuously during the flushing process.
- H. Self-Contained Flush Unit Requirements – Should contain a pump or pumps connected that will meet or exceed the volume required to flush and purge the system at the required velocity rate through the largest pipe. A pump curve will be submitted along with other important documentation for the related equipment on the unit. This will include, at minimum, filtration, flow meter(s), pressure gauges, and unit description or picture.
- I. Pre-Flush - Bypass loops should be installed at all equipment components. Strainers can be removed when a self-contained purge unit is used in conjunction with on board filtration. Flush ports should be identified along with the type of high-pressure hose or piping that will be used to connect to the system. The water source should be identified and must be adequate to fill and make up water in a timely manner to the system during the flush process.
- J. Clear Water Flush – Fill the piping system with clean potable water. The first flush is a clear-water flush intended to circulate water through the system and force loose debris to low point drains and the flush cart filtration system. This flush should be at minimum velocity throughout the system of 5 to 7 ft/sec. Filtration should be 25 microns.
 - 1. For Polypropylene, HDPE Piping Systems – the minimum duration of the flush should be calculated using a formula of 1 hour per 1000 linear feet of pipe and until system water is comparable to make up water source.
- K. Cleaning & Passivation
 - 1. For Metallic Piping Systems - The second flush cycle is a combined flushing cycle where cleaning and passivation chemicals are introduced into the system to clean the oils and treat the inside wall of the piping system. This process will be monitored by the chemical treatment company to meet the chemical specifications of the water. The cleaning velocity should be between 3 to 5 ft/sec and the

circulation time will be based on the chemical testing but will typically be up to 48 hours.

L. Treatment

1. For Metallic Piping Systems - After cleaning and before adding chemical initial charge, system must be flushed to meet these minimum requirements:

- a. Conductivity no higher than 20 mmho above domestic water level
- b. No foam
- c. Copper level less than 0.5 ppm
- d. Iron level less than 1.0 ppm
- e. pH 9.4 or less
- f. Less than 1 ppm phosphates (ortho-phosphate PO₄)

M. Final Chemical Fill – Once the chemical treatment company has determined the system has been brought back to the correct composition, the chemical treatment company will inject the final chemicals into the system. Once the system is filled with the final chemicals it is important that the water is not to be left stagnant. Chemical treatment shall be comparable to existing treatment program.

N. Verify satisfactory completion of clean pipe and a final flushing and chemical treatment report should be signed by field personnel and submitted. Refer to Appendix A for the Flush & Cleaning Hydronic Pipe Field Completion Report

O. In conjunction with piping system cleaning, clean and inspect all strainers and suction diffusers. Remove, bypass, or otherwise protect as necessary all piping system components which may be damaged due to chemical cleaning, including filters, instrumentation gauges, flow meters, etc.

P. After completion of chemical cleaning and flushing, the piping system shall be immediately refilled and maintained with treated water. Under no circumstances shall cleaned piping be allowed to sit empty or filled with untreated water.

3.3 TESTS

A. All piping shall be proven tight at a hydrostatic pressure of 150% of the system design operating pressure, but not less than 125 PSI. The system shall show no loss in pressure or indication of leakage at any joint or connection for a period of 24 hour.

END OF SECTION 23 2114

Appendix A

Flush & Cleaning Hydronic Pipe Field Completion Report

Project Name _____

Date of Report: _____

Project Location: _____

Prime Contractor: _____

Mechanical Firm: _____

Chemical Treatment Firm: _____

Lead Flushing Technician On-Site During Process: _____

Project Type:

- Chilled Water Flush _____
- Other: _____

Scope Summary:

Start Time and Date: _____

End Time and Date: _____

Mechanical Representative_____
Chemical Representative_____
BISD Representative

SECTION 23 8124
CRAC UNIT 1,2,3 AND ACCU-1,2,3 – VERTIV LIEBERT DS SPECIFICATIONS

PART 1 – GENERAL

1.1 SUMMARY

These specifications describe requirements for a Thermal Management system. The system shall be designed to control temperature and humidity conditions in rooms containing electronic equipment, with good insulation and vapor barrier. The manufacturer shall design and furnish all equipment to be fully compatible with heat-dissipation requirements of the room.

1.2 DESIGN REQUIREMENTS

The Thermal Management system shall be a Liebert® self-contained, factory-assembled unit or approved substitution. Standard 60 Hz units shall be CSA-certified to the harmonized U.S. and Canadian product safety standard, “CSA C22.2 No 236/UL 1995 for Heating and Cooling Equipment” and are marked with the CSA c-us logo.

The system shall be AHRI Certified, the trusted mark of performance assurance for heating, ventilation, air conditioning, and commercial refrigeration equipment, using AHRI Standard 1360.

1.3 SUBMITTALS

The specified system shall be factory tested before shipment. Testing shall include but shall not be limited to: Quality Control Checks, Hi-Pot. The manufacturer shall be ISO 9001 certified.

PART 2 - PRODUCT

A. FRAME

The frame shall be welded, formed sheet metal. It shall be protected against corrosion using the autophoretic coating process. The frame shall be capable of being separated into three parts in the field to accommodate rigging through small spaces.

1. Downflow Air Flow Configurations

- a. Downflow Air, Under Floor Discharge
- b. The supply air shall exit from the bottom of the unit.

B. EXTERIOR PANELS

The exterior panels shall be insulated with a minimum 1 in. (25 mm), 1.5 lb. (0.68 kg) density fiber insulation. The main front panel shall have captive quarter-turn fasteners.

C. FILTERS

The filter chamber shall be located within the cabinet, and filters shall be removable from the top of the unit. Filters shall be arranged in a flat bank configuration. Filters, 4-Inch Merv8

D. LOCKING DISCONNECT SWITCHES

- The electrical panel shall provide at least 65,000A SCCR (60 Hz).
- Short circuit current rating (SCCR) is the maximum short circuit current a component or assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.
- Short Circuit Current Rating (SCCR)
- The electrical panel shall provide at least 65,000A SCCR (60 Hz).
- Short circuit current rating (SCCR) is the maximum short circuit current a component or assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.

E. FAN SECTION

- Electronically Commutated (EC) Fan
- The fans shall be plug/plenum type, single inlet and shall be dynamically balanced. The drive package shall be direct drive, electronically commutated, and variable speed. The fans shall be located to draw air over the coil to ensure even air distribution and maximum coil performance.
- DS/VS077 fan motors shall be nominal 4.15 hp (3.1 kW) each with a maximum operating speed of 1,520 rpm; quantity, two.
- DS/VS105 fan motors shall be nominal 3.6 hp (2.7 kW) each, with a maximum operating speed of 1,700 rpm. Quantity: 3.
- Infrared Humidifier
A humidifier shall be factory installed inside the unit. The humidifier shall be of the infrared type, consisting of high intensity quartz lamps mounted above and out of the water supply. The humidifier pan shall be stainless steel and arranged to be removable without disconnecting high voltage electrical connections. The complete humidifier section shall be pre-piped, ready for field connection to the water supply. The humidifier shall be equipped with an automatic water supply system and shall have an adjustable water overfeed to prevent mineral precipitation. A high-water detector shall shut down the humidifier to prevent overflowing. A 1-inch (24 mm) airgap in compliance with ASME A112.1.2 section 2.4.2 (backsiphonage testing) shall prevent backflow of the humidifier supply water. The humidifier shall be removable from the front of the cabinet.
- Three-Stage Reheat
The Thermal Management unit shall include a factory installed reheat to control temperature during dehumidification.
The electric reheat coils shall be low watt density, 304/304 stainless steel fin tubular construction, protected by thermal safety switches, controlled in three stages. The reheat elements shall be removable from the front of the cabinet.

F. REFRIGERATION SYSTEM

1. Evaporator Coil

The evaporator coil shall be A-frame design for downflow units.

It shall be constructed of rifled copper tubes and aluminum fins. A stainless-steel condensate drain pan shall be provided.

G. COMPRESSORIZED SYSTEMS

1. Dual Refrigeration System

Each unit shall include two independent refrigeration circuits and shall include hot gas mufflers (semi-hermetic compressor units only), liquid line filter driers, and refrigerant sight glasses with moisture indicator, externally equalized expansion valves, and liquid line solenoid valves. Compressors shall be located outside the air stream and shall be removable and serviceable from the front of the unit.

2. Semi-Hermetic Compressors with Four Step Unloaders Control

The compressor shall be semi-hermetic with a suction gas cooled motor, vibration isolators, thermal overloads, oil sight glass, automatic reset high pressure switch with control lockout after three failures, low pressure transducer, service valves, reversible oil pumps for forced feed lubrication, a maximum operating speed of 1,750 rpm. The system shall include cylinder unloaders on the semi-hermetic compressors. The unloaders shall be activated by solenoid valves which are controlled from the microprocessor control. In response to the return air

temperature, the microprocessor control shall activate the unloader solenoids and the liquid line solenoids such that four stages of refrigeration cooling are obtained. The stages shall be: 1) one compressor, partially loaded, 2) two compressors partially loaded, 3) one compressor partially loaded, one compressor fully loaded, 4) two compressors fully loaded. On a call for dehumidification, the microprocessor control shall ensure that at least one compressor is on full for proper humidity control.

- Expansion Valve

- Thermostatic Expansion Valve (TXV)

- A manual adjustable externally equalized expansion valve thermostatic expansion valve (TXV) shall control the flow of liquid refrigerant entering the direct expansion coil. The TXV shall maintain consistent superheat of the refrigerant vapor at the outlet of the evaporator coil over the unit's operating range. The TXV shall prevent liquid refrigerant from returning to the compressor.

- Crankcase Heaters

- The compressors shall include crankcase heaters, powered from the indoor unit electric panel.

- R-407C Refrigerant

- The system shall be designed for use with R-407C refrigerant, which meets the EPA clean air act for phase-out of HCFC refrigerants.

Cooling System

- Dual Cool: Chilled Water and Air-Cooled Refrigeration

- 1. System Description

- The dual cooling source system shall consist of an air cooled compressorized system with the addition of a chilled water coil, a modulating control valve, and a comparative temperature sensor. The system shall be able to function either as a modulating chilled water system or as a compressorized system, or a combination of both. The primary mode of cooling shall be chilled water. Switchover between the two cooling modes shall be performed automatically by the microprocessor control.

- 2. Dual Cooling Source - Econ-o-Coil

- The dual cooling source coil shall be constructed with copper tubes and aluminum fins. It shall be located in the return air, before the evaporator coil. The dual cooling source coil shall be rated for a 45°F (7.2°C) entering water temperature.

- Two-Way Modulating Valve

- The water circuit shall include a pre-piped two-way modulating valve. The Liebert® iCOM™ control shall manage valve movement to maintain desired room conditions. The modulating valve travel for dehumidification shall be proportional.

- 3. Chilled Water System Design Pressure

- 0Standard Pressure: The chilled water circuit shall be designed for a pressure of 150 PSI (1,034 kPa).

- 4. Comparator Sensor

- The system shall be equipped with a Liebert® iCOM™ microprocessor-controlled comparator sensor that permits free cooling operation whenever entering chilled water temperature is below return air temperature. The comparator sensor shall be field installed on a free cooling two-way valve.

PART 3 – CONTROLS

3.1 CONTROLS

- A. Vertiv™ Liebert® iCOM™ Microprocessor Control With 7-Inch Color Touchscreen

- The Liebert® iCOM™ shall be microprocessor based with a 7-inch, high definition, capacitive, color touchscreen display and shall be mounted in an ergonomic, aesthetically pleasing housing. The display and housing shall be viewable while the front panel is open or

closed. The controls shall be menu driven. The system shall display user menus for active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in percentage of each function, date and time), total run hours, various sensors, display setup, and service contacts. A password shall be required to make system changes. Service menus shall include setpoints, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards, and diagnostics/service mode. The Liebert® iCOM™ control shall provide Ethernet/RS-485 ports dedicated for BMS connectivity (i.e., Base-Comms).

- Password Protection – The Liebert® iCOM™ shall contain two unique passwords to protect against unauthorized changes. An auto hide/show feature shall allow the user to see applicable information based on the login used.
- Unit Backup/Restore – The user shall be able to create safe copies of important control parameters. The Liebert® iCOM™ shall have the capacity for the user to automatically backup unit configuration settings to internal memory or USB storage drive. Configuration settings may be transferred to another unit for a more streamlined unit startup.
- Parameter Download – The Liebert® iCOM™ shall enable the user to download a report that lists parameter names, factory default settings, and user programmed settings in .csv format for remote reference.
- Parameter Search – The Liebert® iCOM™ shall have search fields for efficient navigation and parameter lookup.
- Parameter Directory – The Liebert® iCOM™ shall provide a directory that lists all parameters in the control. The list shall provide Line ID numbers, parameter labels, and current parameter values.
- Context Sensitive Help – The Liebert® iCOM™ shall have an on-board help database. The database shall provide context sensitive help to assist with setup and navigation of the menus.
- Display Setup – The user shall be able to configure the display information based on the specific user's preference. Language, units of measure, screen contrast, home screen layout, backlight timer and the hide/show of certain readouts shall be configurable through the display.
- Additional Readouts – The display shall enable the user to configure custom widgets on the main screen. Widget options will include items such as fan speed, call for cooling, call for free cooling, maintenance status, call for hot water reheat, call for electric reheat, call for dehumidification, call for humidification, airflow, static pressure, fluid flow rate, and cooling capacity.
- Status LEDs – The Liebert® iCOM™ shall show the unit's operating status using an integral LED. The LED shall indicate if the unit has an active alarm; if the unit has an active alarm that has been acknowledged; or if the unit is On, Off or in standby status.
- Event Log – The Liebert® iCOM™ shall automatically store the last 400 unit only events (messages, warnings, and alarms).
- Service Contact Information – The Liebert® iCOM™ shall be able to store the local service or sales contact information.
- Upgradeable – Vertiv™ Liebert® iCOM™ firmware upgrades shall be performed through a USB connection.
- Timers/Sleep Mode – The menus shall allow various customer settings for turning the unit on or off.
- Menu Layout – The menus shall be divided into two main menus: User and Service. The User screen shall contain the menus to access parameters required for basic unit control and setup. The Service screen shall be designed for service personnel and shall provide access to advanced control setup features and diagnostic information.
- Sensor Calibration – The menus shall allow unit sensors to be calibrated with external sensors.

- Maintenance/Wellness Settings – The menus shall allow reporting of potential component problems before they occur.
- Options Setup – The menus shall provide operation settings for the installed components.
- Auxiliary Boards – The menus shall allow setup of optional expansion boards.
- Various Sensors – The menus shall allow setup and display of optional custom sensors. The control shall include four customer accessible analog inputs for sensors provided by others. The analog inputs shall accept a 4 to 20mA signal. The user shall be able to change the input to 0 to 5 VDC or 0 to 10 VDC. The gains for each analog input shall be programmable from the front display. The analog inputs shall be able to be monitored from the front display. When configuring the analog inputs, the selectable items to choose from shall include air pressure, fluid pressure, temperature, percentage, general amperage, condenser amps, compressor amps, reheat amps, humidifier amps, unit amps, fan amps factory standard, and not used.
- Diagnostics/Service Mode – The Liebert® iCOM™ control shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as on or off at the front display. Control outputs shall be able to be turned on or off from the front display without using jumpers or a service terminal. Each control output shall be indicated by an LED on a circuit board.
- Base-Comms for BMS Connectivity – The Liebert® iCOM™ controller shall provide one Ethernet Port and RS-485 Port dedicated for BMS Connectivity. Provides ground fault isolated RS-485 Modbus, BACnet IP and Modbus IP network connectivity to Building Management Systems for unit monitoring and management. Also, provides ground fault isolated 10/100 baseT Ethernet connectivity for unit monitoring and management. The supported management interfaces include SNMP for Network Management Systems, HTTP for web page viewing, SMTP for email, and SMS for mobile messaging. The Liebert® iCOM™ controller can support dual IP on one network and one 485 protocols simultaneously.

B. Alarms

All unit alarms shall be annunciated through both audio and visual cues, clearly displayed on the screen, automatically recorded in the event log and communicated to the customer's Building Management System/Building Automation System. The Liebert® iCOM™ control shall activate an audible and visual alarm in event of any of the following conditions:

- High Temperature
- Low Temperature
- High Humidity
- Low Humidity
- EC Fan Fault
- Change Filters
- Loss of Air Flow
- Loss of Power
- Compressor Overload
- Humidifier Problem
- High Head Pressure
- Low Suction Pressure
- Custom Alarms

Custom alarm inputs shall be provided to indicate facility specific events. Custom alarms can be identified with programmable labels.

- Leak Under Floor
- Smoke Detected

Each alarm shall be separately enabled or disabled, selected to activate the common alarm and programmed for a time delay of 0 to 255 seconds.

C. Vertiv™ Liebert® iCOM™ Control Methods

1. The Liebert® iCOM™ shall be factory set to allow precise monitoring and control of the condition of the air entering and leaving the unit. This control shall include predictive methods to control air flow and cooling capacity-based control sensors installed. Proportional and Tunable PID shall also be user selectable options.

D. Controlling Sensor

1. Liebert® iCOM™ shall be flexible in the sense that it shall allow for controlling the capacity and fan from multiple different sensor selections. The sensor selections shall be:
 - Cooling Capacity
 - Supply
 - Remote
 - Return
 - Fan Speed
 - Supply
 - Remote
 - Return
 - Manual (for diagnostic or to receive a signal from the BMS through the Liebert® remote monitoring devices or analog input)
 - Static Pressure

E. Temperature Compensation

1. The Vertiv™ Liebert® iCOM™ shall be able to adjust the capacity output based on supply and return temperature conditions to meet SLA guidelines while operating to highest efficiency.

F. Humidity Control

1. Dew point and relative humidity control methods shall be available (based on user preference) for humidity control within the conditioned space.

G. Multi-Unit Coordination

1. Vertiv™ Liebert® iCOM™ teamwork shall save energy by preventing multiple units in an area from operating in opposing modes. Teamwork allows the control to optimize a group of connected cooling units equipped with Liebert® iCOM™ using the U2U (Unit to Unit) network.
 - Teamwork Mode 3 (Optimized Aisle): May be employed in large and small rooms with varying heat loads. Optimized Aisle is the most efficient teamwork mode that allows the unit to match cooling capacity with heat load. In the Optimized Aisle mode, the fans operate in parallel. Fans can be controlled exclusively by remote temperature or using static pressure with a secondary remote temperature sensor(s) as an override to ensure that the inlet rack temperature is being met. Cooling (Compressors or Economizer) is controlled through unit supply air conditions. Liebert® iCOM™ calculates the average or worst-case sensor reading (user selectable) for heating, cooling humidification, and dehumidification. Based on the demand

within the group, units will be allowed to operate within that mode until room conditions are satisfied. This the best form of control for a room with an unbalanced load.

H. Standby Lead-Lag

The Liebert® iCOM™ shall allow scheduled rotation to keep equal run time on units and provide automated emergency rotation of operating and standby units.

I. Standby Unit Cascading

The Liebert® iCOM™ cascade shall allow the units to turn On and Off based on heat load when utilizing Teamwork Mode 3, Optimized Aisle mode with remote temperature sensors. In Teamwork 3 Mode, Cascade mode dynamically coordinates the fan speed to save energy and to meet the cooling demands. For instance, with a Liebert® iCOM™ group of six units and only 50% of the heat load, the Liebert® iCOM™ shall operate only four units at 80% fan speed and leave the other two units in standby.

As the heat load increases, the Liebert® iCOM™ shall automatically respond to the additional load and bring on another unit, increasing the units in operation to five. As the heat load shifts up or down, the control shall meet the needs by cascading units On or putting them into standby.

J. Wired Supply Sensor

Each Vertiv™ Liebert® iCOM™ shall have one factory supplied and connected supply air sensor that may be used as a controlling sensor or reference. When multiple sensors are applied for control purposes, the user shall be able to control based on a maximum or average temperature reading.

K. Virtual Master

As part of the robust architecture of the Vertiv™ Liebert® iCOM™ control, it shall allow for a virtual master that coordinates operation. The Virtual Master function shall provide smooth control operation if the group's communication is compromised. When the lead unit, which is in charge of component staging in teamwork, unit staging and standby rotation, becomes disconnected from the network, the Liebert® iCOM™ shall automatically assign a virtual master. The virtual master shall assume the same responsibilities as the master until communication is restored.

L. Virtual Back Draft Damper

The Vertiv™ Liebert® iCOM™ shall allow the use of a virtual back draft damper, eliminating the need for a mechanical damper. This shall allow the fans to spin slower (15% or less) to act as a damper.

M. Compressor Short Cycle Control

To help maximize the life of the compressor(s), there shall be start-to-next start delay for each single compressor. The control shall monitor the number of compressors starts in an hour. If the compressor starts more than 10 times in 60 minutes, the local display and remote monitoring shall notify the user through a Compressor 1 or 2 Short Cycle event.

N. Vertiv™ Liebert® MC Condenser Communication

The Vertiv™ Liebert® iCOM™ shall communicate directly with the Liebert® MC condenser via field supplied CANbus communication wires and via field supplied, low voltage interlock wires. This shall provide enhanced monitoring, alarming, diagnostics, low noise mode, and condenser fan reversal for cleaning mode.

O. System AutoRestart

The auto restart feature shall automatically restart the system after a power failure. Time delay shall be programmable. An capacitive buffer must be provided for continuous control operation through a power failure.

P. Sequential Load Activation

On initial start-up or restart after power failure, each operational load shall be sequenced with a minimum delay of one second to minimize total inrush current.

Q. Low Pressure Monitoring

Units shall ship standard with low pressure transducers for monitoring individual compressor suction pressure. If the pressure falls due to loss of charge or other mechanical cause, the corresponding circuit shall shut down to prevent equipment damage. The user shall be notified of the low-pressure condition through the local display and remote monitoring.

R. Winter Start Time Delay—Air Cooled Models

1. An adjustable software timer shall be provided to assist with compressor starting during cold weather. When the compressor starts, the low-pressure input shall be ignored for the period set in the user adjustable timer. Once the time period has elapsed after the compressor start, the low-pressure input should remain in the normal state. If the low-pressure input does not remain in the normal state when the time delay has elapsed, the circuit shall lock out on low pressure. The low-pressure alarm shall be announced on the local display and communicated to remote monitoring systems.

S. Advanced Freeze Protection

1. Units shall ship standard with advanced freeze protection enabled. The advanced freeze protection shall monitor the pressure of each circuit using a transducer. The control shall interact with the fan and compressor to prevent the unit coil from freezing if circuit suction pressure drops. Applying fan speed to direct expansion systems requires limitations to avoid freezing condensate on the coil when the unit operates below 100% fan speed. Vertiv™ Liebert® iCOM™ advanced freeze protection provides the ability to predict freeze conditions and correct this condition automatically by adjusting fan speed and compressor capacity. If a freeze condition is detected, the user shall be notified through the local display and remote monitoring systems.

T. Refrigerant Pressure Transducer Failure

1. The control shall monitor the high side and low side refrigerant pressure transducers. If the control senses the transducer has failed, has been disconnected, has shorted or the reading has gone out of range, the user shall be notified through an event on the local display and remote monitoring. The corresponding circuit that the failure has occurred on shall be disabled to prevent unit damage.

U. Oil Return Protection

1. The control shall monitor compressor operation and staging to ensure that liquid and hot gas velocity are maintained for proper oil return to the compressor.

V. Compressor Sequencing

A user selectable compressor sequencing parameter shall be provided and shall be accessible through the local display. This sequencing parameter shall present the user with three choices:

1. Auto: The unit shall automatically stage compressors to keep each unit's run time within eight hours of the other's run time. The Auto setting attempts to maintain equal run times between compressors. However, the control will not turn Off a compressor to equalize run time when it is needed to control the space.
 - First priority: If the safety timings are acceptable for only one compressor, then it is the next to be started/stopped.
 - Second priority: If both compressors are off: The compressor with fewer working hours is the next to start.
 - Third priority: If both compressors are in operation: the compressor that has been operating longer since the last start is the next to be stopped.

W. Compressor High and Low Temperature Limit Protection

The control shall monitor the return air to ensure that the compressor(s) are operated within the manufacturer's defined window of operation. If the return air temperature deviates from the manufacturer's window of operation, the Vertiv™ Liebert® iCOM™ shall automatically adjust to prevent damage to the cooling unit or reduction in its reliability.

X. Compressor Run Time Monitoring

The control shall log these compressor statistics:

- Number of compressors starts.
- Run hours.
- Average run time
- Starts per day.
- Starts per day worst.
- Number of high-pressure alarms
- Operating phase in which the high-pressure alarm occurred.
- Number of low-pressure alarms
- Operating phase in which the low-pressure alarm occurred.
- Number of compressor overloads
- Number of high temperature alarms (scroll compressors)

The user shall have the ability to monitor compressor operating temperature and pressure from the local display to be used as a diagnostic tool.

Y. Manual Compressor Disablement

The user shall have the ability to disable compressor operation using a set of either normally open or normally closed dry contacts tied directly to the control or through remote monitoring. An additional enable/disable feature shall be provided to allow the user to permanently disable an individual compressor circuit for maintenance using the local display.

Z. Manual Compressor Operation

The user shall be able to operate each compressor(s) manually from the local display. The user shall be able to energize refrigeration components including liquid line solenoid valves, compressor contactors, electronic expansion valves, and adjust capacity for troubleshooting or repair. The control shall monitor the compressor during manual operation and shall shut the compressor down if needed to prevent electrical or mechanical damage.

AA. Flooded Start Protection

The control shall isolate each compressor through a dedicated circuit liquid line solenoid valve and/or electronic expansion valve. These devices, combined with an integral compressor check valve (all models) and crankcase heater (air cooled models), shall help ensure refrigerant does not migrate/carry oil out of the compressor case during the off cycle.

BB. Compressor Dehumidification

The control shall permit the user to specify which compressor is used for dehumidification. The choices shall be 1st compressor, 2nd compressor, 1 or 2, or BOTH.

PART 4 - MISCELLANEOUS

4.1 MISCELLANEOUS

A. High Temperature Sensor

The high temperature sensor shall immediately shut down the environmental control system when activated. The high temperature sensor shall be mounted in the electrical panel with the sensing element in the return air.

B. Smoke Sensor

The smoke sensor shall immediately shut down the environmental control system and activate the alarm system when activated. The smoke sensor shall be mounted in the electrical panel

with the sensing element in the return air compartment. The smoke sensor is not intended to function as or replace any room smoke detection system that may be required by local or national codes. The smoke sensor shall include a supervision contact closure.

C. Low Voltage Terminal Package

Factory installed and factory wired terminals shall be provided.

- Remote Shutdown Terminals – Two additional pairs of terminals provide the customer with additional locations to remotely shut down the unit by field installed devices or controls.
- Extra Common Alarm Contacts – Two additional pairs of terminals provide the customer with normally open contacts for remote indication of unit alarms.
- Main Fan Auxiliary Switch – One set of normally open contacts wired to the EC fan motor contactor will close when EC fan operation is required. This set of dry contacts could also be used to initiate air economizer operation. Air economizer and associated devices by others.
- Vertiv™ Liebert® Liqui-tect™ Shutdown – One pair of dry contacts for the Liebert® Liqui-tect™ sensor signal will provide unit shut down. (Liebert® Liqui-tect™ sensor is not included.)

D. Remote Humidifier Contact

1. A pair of N/O contacts provided for connection to a remote humidifier that allows the unit's humidity controller to control a humidifier outside the unit. Power to operate the remote humidifier does not come from the unit.

E. Main Fan Overload

1. A pair of normally open contacts shall be factory installed and wired to indicate Main Fan Overload.

F. Compressor Overload

1. A pair of normally open contacts shall be factory installed and factory wired to each compressor to indicate Compressor Overload.

G/ Wired Remote Sensor(s)

1. Each Vertiv™ Liebert® iCOM™ shall have up to ten 2T sensors (20 sensor readings total) for control or reference. As part of the U2U network, those sensors shall be shared and used to control the units and provide greater flexibility, visibility, and control using that to respond to changes in the data center. When the sensors are used for control, the user may set the control to be based off a maximum or average of a select highest temperature reading.

H. Vertiv™ Liebert® Liqui-tect™ Sensors

1. Provide one solid state water sensors under the raised floor.

I. Floor Stand

1. The floor stand shall be constructed of a welded steel frame. The floor stand shall have adjustable legs with vibration isolation pads. The floor stand shall be 24 inches (mm) high.

J. Vertiv™ Liebert® vNSA Network Switch

1. The Liebert® vNSA network switch is designed for networking multiple Vertiv™ Liebert® iCOM™ unit level controllers together. There shall be two different styles of the vNSA14 panel available:
 - Liebert® vNSA14 – enclosure with network switches only

PART 5 – HEAT REJECTION

5.1 HEAT REJECTION

A. Vertiv™ Liebert® MC Summary

These specifications describe requirements for a Liebert® air cooled condenser for a Liebert® Thermal Management system. The condenser shall be designed to reject waste heat to outdoor air and to control refrigerant head pressure as indoor equipment loading and outdoor ambient conditions change.

The manufacturer shall design and furnish all equipment in the quantities and configurations shown on the project drawings.

Standard 60-Hz units shall be CSA-certified to the harmonized U.S. and Canadian product safety standard CSA C22.2 No 236/UL 1995 for “Heating and Cooling Equipment” and shall be marked with the CSA c-us logo.

B. Vertiv™ Liebert® MC Design Requirements

1. The air-cooled condenser shall be a factory assembled unit, complete with integral electrical panel, designed for outdoor installation. The condenser shall be a draw through design.

C. Vertiv™ Liebert® MC Standard Features

1. Condenser shall consist of microchannel condenser coil(s), propeller fan(s) direct driven by individual fan motor(s), electrical controls, housing, and mounting legs. The Vertiv™ Liebert® air cooled condenser shall provide positive refrigerant head pressure control to the indoor cooling unit by adjusting heat rejection capacity.
2. Microchannel coils shall provide superior heat transfer, reduce air side pressure drop, increase energy efficiency, and significantly reduce the system refrigerant volume required. EC fans and fan operating techniques shall reduce sound levels. Various methods shall be available to match indoor unit type, maximum outdoor design ambient and maximum sound requirements.

D. Vertiv™ Liebert® MC Coil

1. Liebert® MC coils shall be constructed of aluminum microchannel tubes, fins, and manifolds. Tubes shall be flat and contain multiple, parallel flow microchannels and span between aluminum headers. Full depth louvered aluminum fins shall fill spaces between the tubes. Tubes, fins and aluminum headers shall be oven brazed to form a complete refrigerant to air heat exchanger coil. Copper stub pipes shall be electric resistance welded to aluminum coils and joints protected with polyolefin to seal joints from corrosive environmental elements. Coil assemblies shall be factory leak tested at a minimum of 300 psig (2,068 kPag). Hot gas and liquid lines shall be copper and shall be brazed using nitrogen gas flow to the stub pipes with spun closed ends for customer piping connections. Complete coil/piping assembly shall be then filled and sealed with an inert gas holding charge for shipment.
2. Aluminum microchannel coil with E-coat shall be epoxy coated for extended coil life in corrosive environments, such as coastal areas. Factory applied E-coat using immersion and baking process shall provide a flexible epoxy coating to all coil surfaces. Coil color shall be black and shall be protected from solar UV ray degradation with a factory applied UV topcoat. E-coat shall increase coil corrosion protection and shall reduce heat rejection capacity degradation to less than 10% after a severe 2,000- hour, 5% neutral salt spray test (ref. ASTM B117). The coating process shall ensure complete coil encapsulation.

E. Vertiv™ Liebert® MC Fan Motor/Blade Assembly

1. The fan motor/blade assembly shall have an external rotor motor, fan blades and

fan/finger guard. Fan blades shall be constructed of cast aluminum or glass reinforced polymeric material. Fan guards shall be heavy gauge, close meshed steel wire, coated with a black, corrosion resistant finish. Fan terminal blocks shall be in an IP54 enclosure on the top of the fan motor. Fan assemblies shall be factory balanced, tested before shipment, and mounted securely to the condenser structure.

F. Liebert® MC Condenser EC Fan Motor

1. The EC fan motors shall be electronically commutated for variable speed operation and shall have ball bearings. The EC fans shall provide internal overload protection through built-in electronics. Each EC fan motor shall have a built-in controller and communication module linked via RS485 communication wire to each fan and the Premium Control Board, allowing each fan to receive and respond to precise fan speed inputs from the Premium Control Board.

G. Vertiv™ Liebert® MC Electrical Controls

1. Electrical controls and service connection terminals shall be provided, and factory wired inside the attached control panel section. Only high voltage supply wiring and low voltage indoor unit communication/interlock wiring are required at condenser installation.

H. EC Fan Speed and Premium Control

1. The EC fan/Premium Control System shall include an electronic control board, EC fan motor(s) with internal overload protection, refrigerant and ambient temperature thermistors and refrigerant pressure transducers. The Premium Control Board shall communicate directly with the indoor unit's Vertiv™ Liebert® iCOM™ control via field supplied CANbus communication wires and via field supplied low voltage interlock wires. The control board shall use sensor and communication inputs to maintain refrigerant pressure by controlling each EC fan on the same refrigerant circuit to the same speed. The Premium Control Board shall be rated to a temperature of -30°F to 125°F (-34.4°C to 51.7°C). The premium control shall be factory set for (fan speed) (fan speed with Liebert® Lee-Temp) control.

I. Locking Disconnect Switch

1. A locking type disconnect switch shall be factory mounted and wired to the electrical panel and be capable of disrupting the flow of power to the unit and controlled via an externally mounted locking and lockable door handle. The locking disconnect shall be lockable in support of lockout/tagout safety programs.

J. Short Circuit Current Rating

1. The electrical panel shall provide at least 65,000A SCCR.

K. Liebert® MC 575 Volt

1. The condenser cabinet shall include a secondary, factory mounted, NEMA 3R weatherproof electrical enclosure. The secondary enclosure shall contain a 575 V transformer and protective fuses. All wiring between main and secondary electrical enclosures shall be factory provided. All field electrical connections shall be made in the main electrical enclosure.

L. Cabinet

1. The condenser cabinet shall be constructed of bright aluminum sheet and divided into individual fan sections by full width baffles. Internal structural support members, including coil support frame, shall be galvanized steel for strength and corrosion resistance. Panel doors shall be provided on two sides of each coil/fan section to permit coil cleaning. An electrical panel shall be contained inside a factory mounted NEMA 3R weatherproof electrical enclosure. Units with the 575 V shall include a second, factory mounted, NEMA 3R weatherproof electrical enclosure opposite the main electrical enclosure.

M. Vertiv™ Liebert® MC Mounting Legs Standard

1. Legs shall be provided to mount unit for vertical air discharge with rigging holes for hoisting the unit into position. Standard height is 18-inches (457 mm).
- N. Galvanized Steel Legs with Bracing
1. Condensers shall be shipped with (36-inch, 914 mm) (48-inch, 1,219 mm) (60-inch, 1,524 mm) mounting legs with stabilization bracing. Legs, bracing, and hardware shall be galvanized steel.
- O. IBC/OSHPD Seismic Certification and IBC Wind/Snow Load Compliant
- IBC/OSHPD Seismic Certification and IBC Wind/Snow Load Compliant condensers shall be provided with any applicable bracing and field installation instructions. Condensers shall bear a label certifying compliance with IBC/OSHPD requirements.

PART 6 - EXECUTION

6.1 EXECUTION

Installation of Thermal Management Units

A. General

Install thermal management units in accordance with manufacturer's installation instructions. Install units' plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.

B. Electrical Wiring

Install and connect electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.

C. Piping Connections

Install and connect devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.

D. Supply and Drain Water Piping

Connect water supply and drains to air conditioning unit. Provide pitch and trap as manufacturer's instructions and local codes require.

E. Field Quality Control

Start the system in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. These specifications describe requirements for a computer room environmental control system. The system shall be designed to maintain temperature and humidity conditions in the rooms containing electronic equipment.

The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements.

F. Warranty Start-Up and Control Programming

Engage manufacturer's field service technician to provide warranty start-up supervision and assist in programming of unit(s) controls and ancillary panels supplied by them.

END OF SECTION 23 8124

SECTION 23 8125
CRAC-4 AND ACCU-4 – VERTIV LIEBERT PDX SPECIFICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. These specifications describe requirements for a mission critical Thermal Management system. The system shall be designed to control temperature and humidity conditions in rooms containing electronic equipment, with good insulation and vapor barrier. The manufacturer shall design and furnish all equipment to be fully compatible with the heat dissipation requirements of the room.

1.2 DESIGN REQUIREMENTS

- A. The precision Thermal Management system shall be a Liebert® PDX factory- assembled unit or approved substitution. Standard 60 Hz units shall be CSA certified to the harmonized U.S. and Canadian product safety standard, “CSA C22.2 No 236/UL 1995 for Heating and Cooling Equipment” and are marked with the CSA c-us logo. It shall be specifically designed for service from the front and right side of the unit. The system shall be designed for draw-through air arrangement to insure even air distribution to the entire face area of the coil.
- B. The system shall be AHRI Certified, the trusted mark of performance assurance for heating, ventilation, air conditioning and commercial refrigeration equipment, using AHRI Standard 1360.

1.3 SUBMITTALS

- A. Submittals shall be provided with the proposal and shall include single-line diagrams; dimensional, electrical, and capacity data; piping and electrical connection drawings.

1.4 SERVICEABILITY/ACCESS

- A. The cabinet shall be designed so all components are easily accessible for service and maintenance through the front and right sides of the unit.

1.6 QUALITY ASSURANCE

- A. The specified system shall be factory-tested before shipment. Testing shall include but shall not be limited to: Quality Control Checks, “Hi-Pot.” The system shall be designed and manufactured according to world-class quality standards. The manufacturer shall be ISO 9001 certified.

PART 2 - PRODUCT

2.1 COOLING SYSTEM

- A. Dual Cool: Chilled Water + Air Cooled Refrigeration

- 1. System Description

Two independent circuits shall be included. The dual-cooling source system shall consist of an air-cooled system with the addition of a free-cooling chilled water coil or free-cooling chilled glycol coil (Vertiv™ Liebert® Econ-o-Coil), a modulating control valve, and a comparative temperature sensor. The system shall be able to function as a modulating chilled water system, as a compressorized system or as a combination of both. The primary cooling mode shall be chilled water. The secondary refrigeration circuit shall include a liquid-line filter drier, a refrigerant sight glass with moisture indicator, an expansion valve, pressure safety switch and a liquid line solenoid valve. The indoor evaporator refrigerant piping shall be filled with a nitrogen holding charge and spun shut. Field relief of the Schrader valve shall indicate a leak-free system. Switchover between the two cooling modes shall be performed automatically.

by the microprocessor control.

B. Hydrophilic-Coated Evaporator Coil

1. The direct-expansion, tilted-slab cooling coil and the free-cooling chilled water coil shall be constructed of copper tubes and hydrophilic-coated aluminum fins. The hydrophilic coating shall significantly improve the speed of condensate drainage from the fins and shall provide superior water carryover resistance. One stainless steel condensate drain pan shall be provided.

C. R-410A Refrigerant

1. The system shall be designed for use with R-410A refrigerant, which meets the U.S. Clean Air Act for phase out of HCFC refrigerants.

D. Compressor

1. Digital Scroll Compressor

The compressor shall be an R-410A scroll-type with variable capacity operation from 20-100%, commonly known as a digital scroll. The compressor solenoid valve shall unload the digital scroll compressor to provide variable capacity operation. The compressor shall have a suction gas cooled motor, EPDM Rubber vibration isolators, internal thermal overloads, automatic reset high pressure switch with lockout after three failure occurrences, rota-lock service valves, low pressure transducer, and crankcase heater. The compressor shall be removable and serviceable from the front of the unit. The crankcase heater and a discharge check valve shall be provided for additional system protection from refrigerant migration during Off cycles.

2. Compressor Sound Jacket

The compressor sound jacket shall reduce the level of sound emitted from the digital scroll compressor. It shall consist of a 3/8-inch closed cell polymeric 4.5 - 8.5 lb./ft³ density jacket that encloses the compressor.

E. Expansion Valve

1. Thermostatic Expansion Valve (TXV)

A manually adjustable, externally equalized, thermostatic expansion valve (TXV) shall control the flow of liquid refrigerant entering the direct expansion coil. The TXV shall maintain consistent superheat of the refrigerant vapor at the outlet of the evaporator coil over the unit's operating range. The TXV shall prevent liquid refrigerant from returning to the compressor.

F. Dual-Cool: Free-Cooling Control Valve

1. Two-Way Motorized Ball Valve

The water circuit shall include a pre-piped two-way motorized ball valve. The Liebert® iCOM™ shall manage the non-spring return valve actuator movement to maintain the desired room conditions for various entering water temperatures. The motorized ball valve travel for dehumidification shall be proportional.

G. Comparator Sensor

1. The system shall be equipped with a Liebert® iCOM™ microprocessor-controlled comparator sensor that permits free-cooling operation whenever entering chilled water temperature is below return-air temperature. The comparator sensor shall be factory-installed on a free-cooling three-way valve and field-installed on a free-cooling two-way valve.

H. System Design Pressure

1. Standard Pressure

The water circuit shall be designed for a pressure of 150PSI (1034kPa).

2.2 FAN SECTION

A. Fan and Motor

1. The unit shall be equipped with one plug fan: integral direct driven fan with backward-curved blades and electronically commutated DC motor; commonly referred to as EC fan. The fan speed shall be variable and automatically regulated by the Liebert® iCOM™ through all modes of operation. The fan shall have a dedicated motor, fault monitoring circuitry, and speed controller, which shall provide a level of redundancy. The impeller shall be made of aluminum and dynamically balanced. The EC fan shall be located within the unit. The EC fan shall also provide greater energy savings than forward curved centrifugal fan and variable speed drives.

2.3 AIR FLOOR CONFIGURATION

A. Downflow Configurations

1. Downflow Supply with Discharge into Raised Floor

The supply air shall exit from the bottom of the unit directly into the raised floor. The EC fan shall be mounted in the bottom of the unit. The fan shall be located to draw air through the filter and cooling coil to ensure even air distribution and maximum coil performance.

2.4 CABINET CONSTRUCTION AND ACCESSIBILITY

A. Cabinet Construction

1. The exterior panels shall be 20-gauge steel and powder-coated with RAL 7021 black color paint to protect against corrosion. The exterior panels shall be insulated with 1/2" to 1" (12.7 to 25.4mm), 1-1/2 lb. (0.68 kg) insulation. Front and side panels shall have captive, quarter-turn fasteners. The cabinet shall be designed so that all components are serviceable and removable using the front and right sides of the unit.

2.5 LOCKING DISCONNECT SWITCH

- A. A locking-type fused disconnect switch shall be mounted in the electrical panel and shall be capable of disrupting the flow of power to the unit. The locking type shall consist of a main unit switch operational from outside the unit. The electric panel compartment shall be accessible only with the switch in the Off position. The locking disconnect shall be lockable in support of lockout/tagout safety programs.

2.6 SHORT-CIRCUIT CURRENT RATING (SCCR)

- The electrical panel shall provide at least 65,000A SCCR.
- Short-circuit current rating (SCCR) is the maximum short-circuit current a component or assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.

2.7 FILTRATION

A. MERV 8 Filters

The filter shall be an integral part of the system and located within the cabinet. The filter shall be deep-pleated, 2 in. (51mm) thick with a MERV 8 rating efficiency based on ASHRAE 52.2-2007. A filter clog switch shall be included. Mesh type, cleanable filters shall be unacceptable.

2.8 ELECTRIC REHEAT

- A. The reheat shall be a low-watt density 304/304 stainless steel finned-tubular electric reheat. The reheat section shall include UL/CSA recognized safety switches to protect the system from overheating. The electric reheat shall be controlled in two stages. The reheat elements shall be accessible from the right side of the cabinet.

2.9 INFARED HUMIDIFIER

The humidifier shall be of the infrared type, consisting of high intensity quartz lamps mounted above and out of the water supply. The evaporator pan shall be stainless steel and arranged to be serviceable without disconnecting water supply lines, drain lines, or electrical connections. The complete humidifier section shall be pre-piped ready for final connection. The infrared humidification system shall use bypass air to prevent over humidification of the controlled space. The auto flush system shall automatically flush deposits from the humidifier pan. The system shall be field adjustable to change the cycle time to suit local water conditions. A minimum 1 in. (25.4 mm) air gap within the humidifier piping assembly, in compliance with ASME A112.1.2 section 2.4.2 (backsiphonage testing), shall prevent back flow of the humidifier supply water.

PART 3 - CONTROLS

3.1 VERTIV™ LIEBERT® iCOM™ MICROPROCESSOR CONTROL WITH 7 INCH COLOR TOUCHSCREEN

The Liebert® iCOM™ shall be microprocessor-based with a 7-inch, high definition, capacitive, color touchscreen display and shall be mounted in an ergonomic, aesthetically pleasing housing. The display and housing shall be viewable while the front panel is open or closed. The controls shall be menu driven. The system shall display user menus for active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in percentage of each function, date and time), total run hours, various sensors, display setup and service contacts. A password shall be required to make system changes. Service menus shall include setpoints, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards and diagnostics/service mode. The Liebert® iCOM™ control shall provide Ethernet/RS-485 ports dedicated for BMS connectivity (i.e., Base-Comms).

- Password Protection - The Liebert® iCOM™ shall contain two unique passwords to protect against unauthorized changes. An auto hide/show feature shall allow the user to see applicable information based on the login used.
- Unit Backup and Restore - The user shall be able to create safe copies of important control parameters. The Liebert® iCOM™ shall have the capacity for the user to automatically backup unit configuration settings to internal memory or USB storage drive. Configuration settings may be transferred to another unit for a more streamlined unit startup.
- Parameter Download - The Liebert® iCOM™ shall enable the user to download an Liebert® iCOM™ parameter file that lists parameter names, factory default settings and user- programmed settings in .csv format for remote reference.
- Parameter Search - The Liebert® iCOM™ shall have search fields for efficient navigation and parameter lookup.
- Parameter Directory - The Liebert® iCOM™ shall provide a directory that lists all parameters in the control. The list shall provide Line ID numbers, parameter labels, and current parameter values.
- Context-Sensitive Help - The Liebert® iCOM™ shall have an on-board help database. The database shall provide context-sensitive help to assist with setup and navigation of the menus.
- Display Setup - The user shall be able to configure the display information based on the specific user's preference. Language, units of measure, screen contrast, home screen layout, back-light timer, and the hide/show of certain readouts shall be configurable through the display.
- Additional Readouts - The display shall enable the user to configure custom widgets on the main screen. Widget options will include items such as fan speed, call for cooling, call for free-cooling, maintenance status, call for hot water reheat, call for electric reheat, call for dehumidification, call for humidification, airflow, static pressure, fluid flow rate and cooling

capacity.

- Status LEDs - The Liebert® iCOM™ shall show the unit's operating status using an integral LED. The LED shall indicate if the unit has an active alarm; if the unit has an active alarm that has been acknowledged; or if the unit is On, Off or in standby status.
- Event Log - The Liebert® iCOM™ shall automatically store the last 400 unit-only events (messages, warnings, and alarms).
- Service Contact Information - The Liebert® iCOM™ shall be able to store the local service or sales contact information.
- Upgradeable - Vertiv™ Liebert® iCOM™ upgrades shall be performed through a USB connection.
- Timers/Sleep Mode - The menus shall allow various customer settings for turning the unit On or Off.
- Menu Layout - The menus shall be divided into two main menus: User and Service. The User screen shall contain the menus to access parameters required for basic unit control and setup. The Service screen shall be de-signed for service personnel and shall provide access to advanced control setup features and diagnostic information.
- Sensor Calibration - The menus shall allow unit sensors to be calibrated with external sensors.
- Maintenance/Wellness Settings - The menus shall allow reporting of potential component problems before they occur.
- Options Setup - The menus shall provide operation settings for the installed components.
- Auxiliary Boards - The menus shall allow setup of optional expansion boards.
- Various Sensors: The menus shall allow setup and display of optional custom sensors. The control shall include four customer accessible analog inputs for field-supplied sensors. The analog inputs shall accept a 4 to 20mA signal. The user shall be able to change the input to 0 to 5VDC or 0 to 10VDC. The gains for each analog input shall be programmable from the front display. The analog inputs shall be able to be monitored from the front display.
- Diagnostics/Service Mode - The Liebert® iCOM™ control shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as On or Off at the front display. Control outputs shall be able to be turned On or Off from the front display without using jumpers or a service terminal. Each control output shall be indicated by an LED on a circuit board.
- Base-Comms for BMS Connectivity – The Liebert® iCOM™ controller shall provide one Ethernet Port and RS-485 Port dedicated for BMS Connectivity. Provides ground fault isolated RS-485 Modbus, BACnet IP & Modbus IP network connectivity to Building Management Systems for unit monitoring and management. Also, provides ground fault isolated 10/100 baseT Ethernet connectivity for unit monitoring and management. The supported management interfaces include SNMP for Network Management Systems, HTTP for web page viewing, SMTP for email, and SMS for mobile messaging. The Liebert® iCOM™ controller shall support dual IP on a single network and one 485 protocol simultaneously.

3.2 ALARMS

All unit alarms shall be annunciated through both audio and visual cues, clearly displayed on the screen, automatically recorded in the event log and communicated to the customers Building Management System/Building Automation System. The Liebert® iCOM™ control shall activate an audible and visual alarm in event of any of the following conditions:

- High Temperature
- Low Temperature
- High Humidity

- Low Humidity
- EC Fan Fault
- Change Filters
- Loss of Air Flow
- Loss of Power
- Compressor Overload
- Humidifier Problem
- High Head Pressure
- Low Suction Pressure
- Custom Alarms

Custom alarm inputs shall be provided to indicate facility-specific events. Custom alarms can be identified with programmable labels.

- Leak Under Floor
- Smoke Detected
- Standby Unit On

Each alarm (unit and custom) shall be separately enabled or disabled, selected to activate the common alarm and programmed for a time delay of 0 to 255 seconds.

3.3 VERTIV™ LIBERT® iCOM™ CONTROL METHODS

- A. The Liebert® iCOM™ shall be factory-set to allow precise monitoring and control of the condition of the air entering and leaving the unit. This control shall include predictive methods to control air flow and cooling capacity-based control sensors installed. Proportional and Tunable PID shall also be user selectable options.
- B. Controlling Sensor Liebert® iCOM™ shall be flexible in the sense that it shall allow for controlling the capacity and fan from multiple different sensor selections. The sensor selections shall be:

- Cooling Capacity
- Supply
- Remote
- Return

Fan

- Speed
- Supply
- Remote
- Return
- Manual (for diagnostic or to receive a signal from the BMS through the Liebert® remote monitoring devices or analog input)
- Static Pressure

The Vertiv™ Liebert® iCOM™ shall be able to adjust the capacity output based on supply and return temperature conditions to meet SLA guidelines while operating at highest efficiency.

Dew point and relative humidity control methods shall be available (based on user preference) for humidity control within the conditioned space.

3.4 MULTI-UNIT COORDINATION

Liebert® iCOM™ teamwork shall save energy by preventing multiple units in an area from operating in opposing modes. Teamwork allows the control to optimize a group of connected cooling units equipped with Liebert® iCOM™ using the U2U (Unit-to-Unit) network.

- Teamwork Mode 3 (Optimized Aisle): May be employed in large and small rooms with varying heat loads. Optimized Aisle is the most efficient teamwork mode that allows the unit to match cooling capacity with heat load. In the Optimized Aisle mode, the fans operate in parallel. Fans can be controlled exclusively by remote temperature or using static pressure with a secondary remote temperature sensor(s) as an override to ensure that the inlet rack temperature is being met. Cooling (Compressors or Economizer) is controlled through unit supply air conditions. Liebert® iCOM™ calculates the average or worst-case sensor reading (user-selectable) for heating, cooling humidification and dehumidification. Based on the demand within the group, units will be allowed to operate within that mode until room conditions are satisfied. This is the best form of control for a room with an unbalanced load.

3.5 STANDBY LEAD-LAG

The Liebert® iCOM™ shall allow scheduled rotation to keep equal run time on units and provide automated emergency rotation of operating and standby units.

3.6 STANDBY UNIT CASCADING

The Liebert® iCOM™ cascade shall allow the units to turn On and Off based on heat load when utilizing Teamwork Mode 1, Independent mode or Teamwork Mode 3, Optimized Aisle mode with remote temperature sensors. In Teamwork Mode 1, Cascade mode will stage units On based on the temperature and humidity readings and their deviation from setpoint. In Teamwork 3 Mode, Cascade mode dynamically coordinates the fan speed to save energy and to meet the cooling demands. For instance, with a Liebert® iCOM™ group of six units and only 50% of the heat load, the Liebert® iCOM™ shall operate only four units at 80% fan speed and leave the other two units in standby. As the heat load increases, the Liebert® iCOM™ shall automatically respond to the additional load and bring on another unit, increasing the units in operation to five. As the heat load shifts up or down, the control shall meet the needs by cascading units On or putting them into standby.

3.7 WIRED SUPPLY SENSOR

Each Vertiv™ Liebert® iCOM™ shall have one factory-supplied and connected supply air sensor that may be used as a controlling sensor or reference. When multiple sensors are applied for control purposes, the user shall be able to control based on a maximum or average temperature reading.

3.8 VIRTUAL MASTER

As part of the robust architecture of the Liebert® iCOM™ control, it shall allow for a virtual master that coordinates operation. The Virtual Master function shall provide smooth control operation if the group's communication is compromised. When the lead unit, which is in charge of component staging in teamwork, unit staging and standby rotation, becomes disconnected from the network, the Liebert® iCOM™ shall automatically assign a virtual master. The virtual master shall assume the same responsibilities as the master until communication is restored.

3.9 VIRTUAL BACK-DRAFT DAMPER

The Liebert® iCOM™ shall allow the use of a virtual back-draft damper, eliminating the need for a mechanical damper. This shall allow the fans to spin slower (15% or less) to act as a damper.

3.10 COMPRESSOR SHORT CYCLE CONTROL

To help maximize the life of the compressor, there shall be start-to-next start delay for each compressor. The control shall monitor the number of compressors starts in an hour. If the compressor starts more than 10 times in 60 minutes, the local display and remote monitoring shall notify the user through a Compressor Short Cycle event.

3.11 Vertiv™ Liebert® MC CONDENSER COMMUNICATION

The Liebert® iCOM™ shall communicate directly with the Liebert® MC condenser via field-supplied CANbus communication wires and via field-supplied, low voltage interlock wires. This shall provide enhanced monitoring, alarming, diagnostics, low-noise mode, and condenser-fan reversal for cleaning mode.

3.12 SYSTEM AUTORESTART

The auto restart feature shall automatically restart the system after a power failure. Time delay shall be programmable. An optional capacitive buffer may be provided for continuous control operation through a power failure.

3.13 SEQUENTIAL LOAD ACTIVATION

On initial startup or restart after power failure, each operational load shall be sequenced with a minimum delay of one second to minimize total inrush current.

3.14 LOW PRESSURE MONITORING

Units shall ship standard with low pressure transducers for monitoring compressor suction pressure. If the pressure falls due to loss of charge or other mechanical cause, the corresponding circuit shall shut down to prevent equipment damage. The user shall be notified of the low-pressure condition through the local display and remote monitoring.

3.15 WINTER START TIME DELAY—AIR COOLED MODELS

An adjustable software timer shall be provided to assist with compressor starting during cold weather. When the compressor starts, the low-pressure input shall be ignored for the period set in the user-adjustable timer. Once the time period has elapsed after the compressor start, the low-pressure input should remain in the normal state. If the low-pressure input does not remain in the normal state when the time delay has elapsed, the circuit shall lock out on low pressure. The low-pressure alarm shall be announced on the local display and communicated to remote monitoring systems.

3.16 ADVANCED FREEZE PROTECTION

Units shall ship standard with advanced freeze protection enabled. The advanced freeze protection shall monitor the pressure of each circuit using a transducer. The control shall interact with the fan and compressor to prevent the unit coil from freezing if circuit suction pressure drops. Applying fan speed to direct expansion systems requires limitations to avoid freezing condensate on the coil when the unit operates below 100% fan speed. Vertiv™ Liebert® iCOM™ advanced freeze protection provides the ability to predict freeze conditions and correct this condition automatically by adjusting fan speed and compressor capacity. If a freeze condition is detected, the user shall be notified through the local display and remote monitoring systems.

3.17 ADVANCED HIGH-PRESSURE PROTECTION—Models With Digital Scroll Compressors

When the compressor is initially activated, the system shall be monitored for high pressure. When high pressure is detected, the control shall alter the compressor operation and the condenser fan speed to reduce the system discharge pressure, preventing circuit shut down. If the unit is unsuccessful in correcting the problem through this interaction, an alarm shall occur, and the affected compressor shall be immediately locked off. The control shall re-enable the compressor when the pressure returns to a safe level. This feature is standard on units equipped with liquid line transducers and digital scroll.

3.18 REFRIGERANT PRESSURE TRANSDUCER FAILURE

The control shall monitor the high-side and low-side refrigerant pressure transducers. If the control senses the transducer has failed, has been disconnected, has shorted or the reading has gone out of range, the user shall be notified through an event on the local display and remote monitoring. The corresponding circuit that the failure has occurred on shall be disabled to prevent unit damage.

3.19 OIL RETURN PROTECTION

The control shall monitor compressor operation and staging to ensure that liquid and hot gas velocity are maintained for proper oil return to the compressor.

3.20 DIGITAL SCROLL HIGH TEMPERATURE PROTECTION

The control shall monitor digital scroll temperature during unit operation. A compressor temperature limit shall be imposed to help prevent damage to the compressor. If the temperature reaches the maximum temperature limit, the compressor shall be locked out for 30 minutes and an alarm shall be annunciated on the local display and through monitoring. After the initial lockout, the control shall continue to monitor compressor temperature during the off-cycle and re-enable the circuit once a safe operating temperature is reached and the 30 minutes has elapsed. The control shall store the number of high temperature trips. The number of trips shall be accessible through the local display.

3.21 DIGITAL SCROLL SENSOR FAILURE

The control shall monitor the status of the digital scroll sensor(s). If the control senses that the thermistor is disconnected, shorted or the reading goes out of range, the user shall be notified through an event on the local display and remote monitoring.

3.22 COMPRESSOR HIGH AND LOW TEMPERATURE LIMIT PROTECTION

The control shall monitor the return air to ensure that the compressor is operated within the manufacturer's defined window of operation. If the return air temperature deviates from the manufacturer's window of operation, the Liebert® iCOM™ shall automatically adjust to prevent damage to the cooling unit or reduction in its reliability.

3.23 COMPRESSOR RUN TIME MONITORING

The control shall log these compressor statistics:

- Number of compressors starts.
- Run hours.
- Average run time
- Starts per day.
- Starts per day worst.
- Number of high-pressure alarms
- Operating phase in which the high-pressure alarm occurred.
- Number of low-pressure alarms
- Operating phase in which the low-pressure alarm occurred.
- Number of compressor overloads
- Number of high temperature alarms (scroll compressors)

The user shall have the ability to monitor compressor operating temperature and pressure from the local display to be used as a diagnostic tool.

3.24 FLOODED START PROTECTION

The control shall isolate each compressor through a dedicated circuit liquid line solenoid valve and/or electronic expansion valve. These devices, combined with a spring-closed discharge check valve and compressor crank-case heater (air cooled models), shall help ensure refrigerant does not migrate/carry oil out of the compressor case during the off cycle.

PART 4 – MISCELLANEOUS OPTIONS

4.1 HIGH TEMPERATURE SENSOR

This sensor shall be factory-installed in the unit and shall be factory-set to 125°F (52°C). It shall immediately shut down the environmental control system when activated. The sensor shall be mounted with the sensing element in the return air. This sensor is not meant to replace any fire detection system that may be required by local or national codes.

4.2 SMOKE SENSOR

The smoke sensor samples the return air, shuts down the unit upon activation, and sends visual and audible alarms. Dry contacts are available for a remote customer alarm. The smoke sensor includes a “supervision” contact closure. This smoke sensor is not intended to function as or replace any room smoke detection system that may be required by local or national codes.

4.3 REMOTE TEMPERATURE/HUMIDITY SENSOR

This sensor shall allow the control of the unit based on temperature/humidity conditions remote to the unit. This sensor shall be field-mounted and wired to the Vertiv™ Liebert® iCOM™ control board and the unit shall not have a return-air temperature/humidity sensor mounted inside the unit.

4.4 LOW VOLTAGE TERMINAL PACKAGE

Factory-installed and factory-wired terminals shall be provided for customer connection:

- Remote Shutdown Terminals - Two additional pairs of terminals provide the customer with additional locations to remotely shut down the unit by field-installed devices or controls.
- Extra Common Alarm Contacts - Two additional pairs of terminals provide the customer with normally open contacts for remote indication of unit alarms.
- Main Fan Auxiliary Switch - One set of normally open contacts wired to the EC fan motor contactor will close when EC fan operation is required. This set of dry contacts could also be used to initiate air economizer operation. Air economizer and associated devices by others.
- Vertiv™ Liebert® Liqui-Tect™ Shutdown - One pair of dry contacts for the Liebert® Liqui-Tect™ sensor signal will provide unit shut down. (Liebert® Liqui-Tect™ sensor is not included)

4.5 REMOTE HUMIDIFIER CONTACT

A pair of N/O contacts provided for connection to a remote humidifier that allows the unit's humidity controller to control a humidifier outside the unit. Power to operate the remote humidifier does not come from the unit.

4.6 COMPRESSOR OVERLOAD

A factory-installed sensor designed to detect high compressor currents and provide Liebert® iCOM™ input to shut down the compressor as a compressor protection feature.

4.7 FLOOR STAND

A. Supply Air Floor Stand -Downflow Raised Floor

THE FLOOR STAND SHALL BE CONSTRUCTED OF GALVANIZED STEEL. THE FLOOR STAND SHALL HAVE ADJUSTABLE LEGS WITH VIBRATION ISOLATION PADS. THE FLOOR STAND SHALL BE: (24 IN. [61CM]) HIGH.

4.8 VERTIV™ LIEBERT® VNSA NETWORK SWITCH-OPTIONAL

The Liebert® vNSA network switch is designed for networking multiple Vertiv™ Liebert® iCOM™ unit- level controllers together. There shall be two different styles of the Liebert® vNSA14 panel available:

- Liebert® vNSA14: enclosure with network switches only

4.9 VERTIV™ LIEBERT® NFORM ADVANCED MONITORING

The Critical Infrastructure Management software shall centrally monitor and manage distributed equipment using the customer's existing network infrastructure. The system shall provide the Critical Infrastructure Management and Monitoring for air conditioning (CRAC) systems, uninterruptible power supply (UPS) systems, power distribution units (PDUs), static transfer switches (STS), direct current power systems (DC), power distribution strips (PDUs), Vertiv™ Liebert® Alber™ battery monitoring, rack enclosure intrusion monitoring, leak detection systems and other critical

infrastructure systems as specified. The system shall have an architecture that allows up to 10,000 managed devices, including Liebert and third-party devices, in a single-server installation.

4.9.1 APPROVED PRODUCTS

The Critical Infrastructure Monitoring System shall be Vertiv™ Liebert® Nform as manufactured by Vertiv. No substitutions shall be accepted.

4.10 VERTIV™ LIEBERT® LIQUI-TECT™ 410 POINT LEAK DETECTION SENSOR FOR REMOTE MOUNTING

- A. A total of one solid-state water sensor(s) with no moving parts and hermetically sealed to keep out dust and dirt shall be provided. The Liebert® Liqui-Tect™ 410 (LT410) shall provide a single- point detection of leaks. The point detection sensor shall have two gold-plated sensing probes to prevent corrosion resistance and to provide accurate readings. The LT410 shall constantly monitor points for leaks, internal faults, and power failures and warn of any abnormal conditions. Mounting brackets shall allow for sensor height adjustment and leveling. The LT410 shall provide two independent outputs to signal both a local alarm panel and a remote building management system or external equipment. The LT410 shall be rated for 24VAC, 50/60Hz and 0.10 amps.

4.11 LIEBERT® LIQUI-TECT™ 460 ZONE LEAK DETECTION MODULE WITH CABLE KIT FOR REMOTE MOUNTING

- A. A total of one zone water sensor cables with no moving parts and hermetically sealed to keep out dust and dirt shall be provided. The Liebert® Liqui-Tect™ 460 (LT460) shall provide a zone detection of leaks. The LT460 shall constantly monitor points for leaks, internal faults, and power failures and warn of any abnormal conditions. LED's shall provide status indication and also ensure the cable is properly installed and operational under raised floors. The LT460 shall provide two independent outputs provide a signal to a local alarm panel, Liebert environmental unit, remote building management system, or external equipment.
- B. Liebert® Liqui-Tect™ 460 Module
- C. The LT460 shall consist of a metal enclosure with a hinged top door providing access to the internal circuit board for wiring termination and configuration of DIP switches. The LT460 shall monitor up to 100 feet (30m) of connected LT500Y leak detection cable. The LT460 shall be rated for 24VAC, 50/60Hz, and 0.12A.
- D. LT500Y Leak Detection Cable
1. The cable material and construction shall allow the cable to lie flat when used with hold-down clips. The LT500Y shall be plenum-rated and UL-listed for safe operation. Cables shall be available in lengths of 20, 25, 30, 35, and 45 feet (6, 7.6, 9, 10.6, and 13.7m).

PART 5 - HEAT REJECTION - VERTIV™ LIEBERT® MC CONDENSER

5.1 LIEBERT® MC CONDENSER SUMMARY

- These specifications describe requirements for a Liebert air cooled condenser for a Liebert Thermal Management system. The condenser shall be designed to reject waste heat to outdoor air and to control refrigerant head pressure as indoor equipment loading and outdoor ambient conditions change.
- The manufacturer shall design and furnish all equipment in the quantities and configurations shown on the project drawings.
- Standard 60Hz units shall be CSA-certified to the harmonized U.S. and Canadian product safety standard “CSA C22.2 No 236/UL 1995 for Heating and Cooling Equipment” and shall be marked with the CSA c-us logo.

5.2 LIEBERT® MC CONDENSER DESIGN REQUIREMENTS

The air-cooled condenser shall be a factory-assembled unit, complete with integral electrical panel, designed for outdoor installation. The condenser shall be a draw-through design.

5.3 LIEBERT® MC CONDENSER STANDARD FEATURES

Condenser shall consist of microchannel condenser coil(s), propeller fan(s) direct driven by individual fan motor(s), electrical controls, housing, and mounting legs. The Liebert air cooled condenser shall provide positive refrigerant head pressure control to the indoor cooling unit by adjusting heat rejection capacity. Microchannel coils shall provide superior heat transfer, reduce air-side pressure drop, increase energy efficiency, and significantly reduce the system refrigerant volume required. EC fans and fan operating techniques shall reduce sound levels. Various methods shall be available to match indoor unit type, maximum outdoor design ambient and maximum sound requirements.

5.4 LIEBERT® MC CONDENSER COIL

Liebert® microchannel coils shall be constructed of aluminum microchannel tubes, fins, and manifolds. Tubes shall be flat and contain multiple, parallel flow microchannels and span between aluminum headers. Full-depth louvered aluminum fins shall fill spaces between the tubes. Tubes, fins, and aluminum headers shall be oven-brazed to form a complete refrigerant-to-air heat exchanger coil. Copper stub pipes shall be electric resistance welded to aluminum coils and joints protected with polyolefin to seal joints from corrosive environmental elements. Coil assemblies shall be factory leak tested at a minimum of 300 psig (2068kPag). Hot gas and liquid lines shall be copper and shall be brazed using nitrogen gas flow to the stub pipes with spun-closed ends for customer piping connections. Complete coil/piping assembly shall be then filled and sealed with an inert gas holding charge for shipment.

A. Aluminum Microchannel Coil with E-Coat

Aluminum microchannel coil with E-coat shall provide a flexible epoxy coating to all coil surface areas without material bridging between fins. E-coat shall increase coil corrosion protection and shall reduce heat rejection capacity degradation to less than 10% after a severe 2000-hour 5% neutral salt spray test (ref. ASTM B117). The coating process shall ensure complete coil encapsulation, and the color shall be black. A UV topcoat shall be applied to prevent UV degradation of E-coat.

5.5 VERTIV™ LIEBERT® MC CONDENSER FAN MOTOR/BLADE ASSEMBLY

The fan motor/blade assembly shall have an external rotor motor, fan blades and fan/finger guard. Fan blades shall be constructed of cast aluminum or glass-reinforced polymeric material. Fan guards shall be heavy gauge, close-mesh steel wire, coated with a black corrosion resistant finish. Fan terminal blocks shall be in an IP54 enclosure on the top of the fan motor. Fan assemblies shall be factory-balanced, tested before shipment and mounted securely to the condenser structure.

A. Liebert® MC Condenser EC Fan Motor

The EC fan motors shall be electronically commutated for variable speed operation and shall have ball bearings. The EC fans shall provide internal overload protection through built-in electronics. Each EC fan motor shall have a built-in controller and communication module, linked via RS485 communication wire to each fan and the Premium Control Board, allowing each fan to receive and respond to precise fan speed inputs from the Premium Control Board.

5.6 LIEBERT® MC CONDENSER ELECTRICAL CONTROLS

Electrical controls and service connection terminals shall be provided and factory-wired inside the attached control panel section. Only high-voltage supply wiring and low voltage indoor unit communication/interlock wiring are required at condenser installation.

A. EC Fan Speed and Premium Control

The EC fan/Premium Control System shall include an electronic control board, EC fan motor(s) with internal overload protection, refrigerant and ambient temperature thermistors, and refrigerant pressure transducers. The Premium Control Board shall communicate directly with the indoor unit's Vertiv™ Liebert® iCOM™ control via field-supplied CANbus communication wires and via field-supplied low voltage interlock wires. The control board shall use sensor and communication inputs to maintain refrigerant pressure by controlling

each EC fan on the same refrigerant circuit to the same speed. The Premium control board shall be rated to a temperature of -30°F to 125°F. The premium control shall be factory set for (fan speed) (fan speed with Vertiv™ Liebert® Lee-Temp) (fan speed with unheated receivers for EEV) control.

B. Locking Disconnect Switch

A Locking-Type disconnect switch shall be factory-mounted and wired to the electrical panel and be capable of disrupting the flow of power to the unit and controlled via an externally mounted locking and lockable door handle. The locking disconnect shall be lockable in support of lockout/tagout safety programs.

C. Short Circuit Current Rating

The electrical panel shall provide at least 65,000A SCCR.

D. Condenser Cabinet

The condenser cabinet shall be constructed of bright aluminum sheet and divided into individual fan sections by full width baffles. Internal structural support members, including coil support frame, shall be galvanized steel for strength and corrosion resistance. Panel doors shall be provided on two sides of each coil/fan section to permit coil cleaning. An electrical panel shall be contained inside a factory mounted NEMA 3R weatherproof electrical enclosure.

5.7 Vertiv™ Liebert® MC Condenser Mounting Legs

A. Standard Legs

Legs shall be provided to mount unit for vertical air discharge with rigging holes for hoisting the unit into position. Standard height is 18 in. (457mm).

B. Liebert® MC 575 Volt - Optional

The condenser cabinet shall include a secondary, factory mounted, NEMA 3R weatherproof electrical enclosure. The secondary enclosure shall contain a 575V transformer and protective fuses. All wiring between main and secondary electrical enclosures shall be factory-provided. All field electrical connections shall be made in the main electrical enclosure.

5.8 IBC/OSHPD Seismic Certification and IBC Wind/Snow Load Compliant—Optional

- A. IBC/OSHPD Seismic Certification and IBC Wind/Snow Load Compliant condensers shall be provided with any applicable bracing and field-installation instructions. Condensers shall bear a label certifying compliance with IBC/OSHPD requirements.

PART 6 - EXECUTION

6.1 INSTALLATION OF PRECISION COOLING UNITS

A. General

Install precision cooling units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

6.2 ELECTRICAL WIRING

- A. Install and connect electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.

6.3 PIPING CONNECTIONS

- A. Install and connect devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.

6.4 FIELD QUALITY CONTROL

- A. Start the system in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements. These specifications describe requirements for a computer room environmental control system. The system shall be designed to maintain temperature and humidity conditions in the rooms containing electronic equipment.

The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements.

6.5 SUPPLY AND DRAIN WATER PIPING

- A. Connect water supply and drains to air conditioning unit. Provide pitch and trap as manufacturer's instructions and local codes require.

6.6 WARRANTY START-UP AND CONTROL PROGRAMMING

- A. Engage manufacturer's field service technician to provide warranty start-up supervision and assist in programming of unit(s) controls and ancillary panels supplied by them.

END OF SECTION 23 8125

SECTION 25 0900
HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General: The Building management system (BMS) system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and a web-based operator interface.
- B. System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. The control system server shall be accessed using a Web browser over the control system network, the owner's local area network and (at the owner's discretion) over the Internet. The server shall also act as a "workstation" when running as a server/client platform. Additional clients shall have concurrent access to the "workstation" in this mode.
- C. The intent of the thin-client architecture is to provide operators complete access to the control system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to download programming into the controllers.
- D. System shall use BACnet protocol for communication between the control modules and web server. Communication between the web server and the user's browser shall be HTTP or HTTPS protocol utilizing HTML5. Use of Adobe Flash technology is not acceptable.
- E. New devices shall be integrated into the existing Automated Logic system. This includes adding the devices to the existing database and modification or addition of graphics using the Automated Logic interface. Integration of these devices shall be included with this bid.

1.2 APPROVED BMS SYSTEMS

- A. Approved control system supplier, manufacturer, and product line:
 - 1. Automated Logic Corporation, WebCTRL

1.3 DEFINITIONS

- A. Adjustable (adj.): Adjustable by the end user, through the supplied user interface.
- B. Advanced Application Controllers (AACs): A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read & write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet.
- C. Web Services: Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system.

- D. Alarm: The control system shall be configured to generate an alarm when this object exceeds user definable limits, as described in the Sequence of Controls.
- E. Analog Value: An intermediate (software) point that may be editable or read-only. Editable AVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only AVs are typically used to display the status of a control operation.
- F. Application Specific Controllers (ASCs): A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can chose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.
- G. BACnet Interoperability Building Blocks (BIBB): A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification.
- H. BACnet/BACnet Standard: BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
- I. Binary Value: An intermediate (software) point that may be editable or read-only. Editable BVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only BVs are typically used to display the status of a control operation.
- J. Building Controllers (BCs): A fully programmable control module which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically, this controller is located on the Ethernet/IP backbone of the BAS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.
- K. Control Systems Server: A computer(s) that maintain(s) the systems configuration and programming database.
- L. Controller: Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.
- M. Direct Digital Control: Microprocessor-based control including Analog/Digital conversion and program logic.
- N. Furnished or Provided: The act of supplying a device or piece of equipment as required meeting the scope of work specified and making that device or equipment operational. All costs required to furnish the specified device or equipment and make it operational are borne by the division specified to be responsible for providing the device or equipment.
- O. Gateway: Bi-directional protocol translator connecting control systems that use different communication protocols.
- P. Install or Installed: The physical act of mounting, piping, or wiring a device or piece of equipment in accordance with the manufacturer's instructions and the scope of work as specified. All costs

required to complete the installation are borne by the division specified to include labor and any ancillary materials.

- Q. Integrate: The physical connections from a control system to all specified equipment through an interface as required to allow the specified control and monitoring functions of the equipment to be performed via the control system.
- R. Interface: The physical device required to provide integration capabilities from an equipment vendor's product to the control system. The equipment vendor most normally furnishes the interface device. An example of an interface is the chilled water temperature reset interface card provided by the chiller manufacturer in order to allow the control system to integrate the chilled water temperature reset function into the control system.
- S. Local Area Network: Computer or control system communications network limited to local building or campus.
- T. Loop or control loop: Most commonly a PID control loop. Typically, a control loop will include a setpoint, an input which is compared to the setpoint, and an output which controls some action based upon the difference between the input and the setpoint. A PID control loop will also include gains for the proportional, integral, and derivative response as well as an interval which controls how frequently the control loop updates its output. These gains may be adjustable by the end user for control loop "tuning," but in self-tuning control loops or loops which have been optimized for a specific application the gains may not be adjustable.
- U. Master-Slave/Token Passing (MS/TP): Data link protocol as defined by the BACnet standard.
- V. Point-to-Point: Serial communication as defined in the BACnet standard.
- W. Primary Controlling LAN: High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
- X. Protocol Implementation Conformance Statement (PICS): A written document that identifies the options specified by BACnet that are implemented in a device.
- Y. Router: A device that connects two or more networks at the network layer.
- Z. Schedule: The control algorithm for this equipment shall include a user editable schedule.
- AA. Trend: The control system shall be configured to collect and display a trend log of this object. The trending interval shall be no less than one sample every 5 minutes. (Change of Value trending, where a sample is taken every time the value changes by more than a user-defined minimum, is an acceptable alternative.)
- BB. Wiring: Raceway, fittings, wire, boxes, and related items.

1.4 QUALITY ASSURANCE

- A. Installer and Manufacturer Qualifications

11. Installer shall have an established working relationship with the Control System Manufacturer and have, as a minimum, 5 years demonstrated experience with installation and support of the manufacturer's product.
12. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

1.5 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances for these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
 1. National Electric Code (NEC)
 2. International Building Code (IBC)
 3. International Mechanical Code (IMC)
 4. Underwriters Laboratories (UL/CUL)
 5. ANSI/ASHRAE Standard 135, BACnet – A Data Communication Protocol for Building Automation and Control Systems.

1.6 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for display through the user's web browser.
 1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
 2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
 3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
 4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
 5. Alarm Response Time. An object that goes into alarm shall be annunciated at the browser within 45 sec.
 6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec.

7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each user, connected to network accessing the system through their browser (workstation), shall receive alarms within 5 seconds of one another.
9. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances shown in table below:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	± 0.2 in. w.g. (± 0.01 in. w.g.)	0–6 in. w.g. –0.1 to 0.1 in. w.g.
Airflow	$\pm 10\%$ of full scale	
Space Temperature	$\pm 2.0^{\circ}\text{F}$	
Duct Temperature	$\pm 2.0^{\circ}\text{F}$	
Humidity	$\pm 5\%$ RH	
Fluid Pressure	± 1.5 psi ± 1.0 in. w.g.	1–150 psi 0–50 in. w.g. differential

1.7 SUBMITTALS

- A. Product Data and Shop Drawings: The contractor shall provide shop drawings and product data on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Provide submittal data in a digital format on suitable digital media such as a USB drive. The submittal data shall be in standard Microsoft (Word, Excel, etc.) or PDF file formats. The shop drawings shall be formatted to fit on 11" x 17" pages and hardware/software product data shall be formatted to fit on 8.5" x 11" pages. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Submittals shall be provided within 12 weeks of contract award. Submittals shall include:

1. DDC System Hardware

- a. A complete bill of materials to be used indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
- b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:

- 1) Direct digital controllers (controller panels)

- 2) Transducers and transmitters
 - 3) Sensors (including accuracy data)
 - 4) Actuators
 - 5) Valves
 - 6) Relays and switches
 - 7) Control panels
 - 8) Power supplies
 - 9) Batteries
 - 10) Operator interface equipment
 - 11) Wiring
 - c. Wiring diagrams and layouts for each control panel. Show termination numbers.
 - d. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Central System Hardware and Software
- a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and relevant technical.
 - b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
 - 1) Central Processing Unit (CPU) or web server
 - 2) Monitors
 - 3) Keyboards
 - 4) Power supplies
 - 5) Battery backups
 - 6) Interface equipment between CPU or server and control panels
 - 7) Operating System software – web server
 - 8) Color graphic software

- 9) Third-party software
 - c. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
 - d. Network riser diagrams of wiring between central control unit and control panels.
3. Controlled Systems
- a. Riser diagrams showing control network layout, communication protocol, and wire types.
 - b. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - c. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - d. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - e. A mounting, wiring, and routing plan-view drawing. The design shall take into account HVAC, electrical and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
 - f. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - g. A point list for each control system. List I/O points and software points required to provide specified sequence of operations. Indicate alarmed and trended points.
4. Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.
5. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

B. Project Documentation

- 1. Upon completion of installation, submit record (as-built) documents for approval before final completion. Provide record documents in a digital format on suitable digital media such as a USB drive. The record documents shall be in standard Microsoft (Word, Excel, etc.) or PDF file formats except as noted below. Record documentation shall include the following:
 - a. Project Record Drawings.

- b. Testing and Commissioning Reports and Checklists.
 - c. Operation and Maintenance (O&M) Manual.
 - d. As-built versions of submittal product data.
 - e. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - f. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - g. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - h. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - i. Documentation of programs operating in the system and object database that can be viewed using technician software tools furnished with system.
 - j. Graphic files, programs, and database to be viewed using technician software tools furnished with system.
 - k. List of recommended spare parts with part numbers and suppliers.
 - l. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - m. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 - n. Licenses, guarantees, and warranty documents for equipment and systems.
 - o. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
2. Load into the control system for access by the operator through any operator workstation closeout documentation. There shall be a menu or navigation tab to access the documentation. The documentation can be loaded into the control system in a pdf format. The following documentation shall be included:
- a. As-built control diagrams including wiring diagrams and sequences of operations for each controller/piece of equipment.
 - b. All IOM data as follows:
 - 1) IOM from each equipment manufacturer for each piece of equipment (AHUs, FCUs, Chillers, pumps etc.)
 - 2) IOM for each control module and end device installed in the system.
- C. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class.

1.8 WARRANTY

- A. Warrant work as follows:

1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.
2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
3. If the engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
4. All Manufacturer's software/firmware for web server/workstation and controllers shall be updated to the latest versions that are available from the manufacturer within 30 days from the date of end of the warranty. These updates shall be installed and checked out before the end of the warranty.
5. Provide updates to web server software, project-specific software, graphic software, database software, and firmware that resolve the contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
6. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired and factory recertified. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

1.9 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
 1. Graphics
 2. Record drawings
 3. Database
 4. Application programming code
 5. Documentation

1.10 PRODUCTS FURNISHED BY OTHERS AND INTEGRATED WITH BMS:

- A. General: The BMS shall be capable of integrating to any third-party equipment using the following standard open protocols:

11. BACnet (IP, SC, ARCnet, or MS/TP)
 12. Modbus (RTU or IP)
- B. The third-party equipment provider shall provide the details of the proposed interface including PICS for BACnet equipment, hardware and software identifiers for the interface points, network identifiers, wiring requirements, communication speeds, and required network accessories.
- C. The third-party equipment provider is responsible for furnishing and installing their interface pre-programmed and configured with the correct parameters to integrate with the BMS. These parameters include, but are not limited to the following:
1. Communication protocol
 2. Correct communication protocol baud rate
 3. Points required to be viewed through the BMS. This includes ensuring the points are “in service” and visible to the BMS.
 4. Addressing of controller/interface. The BMS provider shall furnish the address.
- D. The third-party equipment manufacturer shall include a minimum of 16 hours of onsite technical support for integration into the BMS.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. All IP based controllers shall be capable of providing IPv4 and IPv6 protocol standards as defined by the Internet Data Communications Standard.
- C. The BMS contractor shall furnish and install all communication media, connectors, repeaters and network switches/routers, and network devices necessary to provide a complete and workable control network for both high speed Ethernet communications network/LAN and serial networks. The control network shall adhere to the owner’s testing, labeling, administration, and documentation requirements established and presented for the site. The dedicated control's network shall be capable of connecting to a separate owner/customer LAN.
- D. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- E. Internetwork operator interface and value passing shall be transparent to internetwork architecture.

1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified sequences of operations. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- F. BACnet Secure Connect (BACnet/SC). BACnet/SC is a datalink option that makes the full use of TLS WebSocket connections as defined by addendum bj to the ANSI/ASHRAE Standard 135.
1. The BMS contractor shall furnish and install a network designed to allow for implementation of BACnet/SC. The network shall be installed with as many devices capable of using BACnet/SC at time of installation.
 2. The BMS contractor shall furnish and install all BACnet workstations/servers, routers, and building controllers capable of using BACnet/SC. Any BACnet workstations/servers, routers, or building controllers that do not have BACnet/SC capability at time of installation shall have the ability to provide BACnet/SC capability with a software/firmware update/patch. BACnet/SC capability shall not require the physical replacement of the BACnet workstation/server, router, or building controller hardware.
- G. Building Control Panels and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.
- H. System shall be expandable to at least twice the required BACnet objects. No additional licensing/software fees shall be required to add controllers, associated devices, and wiring.
- I. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 3. For read or write requests, the system shall require username and password authentication and shall support TLS (Transport Layer Security) or equivalent data encryption.
 4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow

a third-party Web services device to read data from or write data to any object in the system which supports this service.

2.3 OPERATOR INTERFACE

- A. Operator Interface. The web server shall reside on a high-speed network with the building controllers. Web pages generated by this server shall be compatible with the latest versions of Microsoft Internet Explorer or Edge, Google Chrome, Mozilla Firefox, and Apple Safari browsers. Any of these supported browsers connected to the server shall be able to access all system information. Mobile devices shall be recognized by the web server and shall supply the appropriate system content as needed. The Operator Interface (web server with client devices) shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L. This includes the ability to configure and/or reconfigure the system from the client device (change programs, graphics, labels, etc.).
- B. Communication. Web server and controllers shall communicate using BACnet protocol, including BACnet/SC. Web server and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J. Communication between the web server and client (workstation) shall be HTTP or HTTPS protocol utilizing HTML5 language. Use of Adobe Flash in any part of the communication infrastructure is not acceptable.
- C. Hardware.
 - 1. Web server and/or workstation. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The web server may also be configured in client/server fashion to accommodate a "workstation" definition. In "workstation" configuration, the workstation will also perform as a server supplying additional clients as needed. The following hardware requirements apply:
 - a. System storage shall have sufficient memory to accommodate:
 - 1) All required system software.
 - 2) A DDC database to accommodate, as a minimum, twice the size of the delivered system database.
 - 3) One year of archival trend data based on the points specified to be trended at their specified trend intervals.
 - b. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.
 - c. Minimum hardware configuration shall include the following:
 - 1) Quad Core Processor
 - 2) 4-24 GB RAM (size dependent on size of system)

- 3) 500 GB hard disk providing data at 3.0 Gb/sec (size dependent on historical data storage requirements)
- 4) 16x DVD+/-RW drive
- 5) Qwerty Keyboard
- 6) Optical Mouse
- 7) 24-inch LED Color monitor with 75Hz refresh rate and 1080P resolution to provide a minimum screen resolution of 1920 x 1080 pixels.
- 8) Serial (USB) and network communication ports, with cables as required for proper DDC system operation.

D. System Software.

1. Operating System. Web server shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the BMS manufacturer's minimum requirements for their software. Acceptable systems include Microsoft Windows 8.1 or 10, Windows Server 2012 R2 or 2016 or 2019 or 2020, Red Hat Enterprise Linux 8.3, or Ubuntu Desktop 18.04 or 20.04 TLS.
2. Security. The web server application shall support Transport Layer Security (TLS) 1.3 capable of encryption of up to 256-bit elliptical curve for transmitting private information over the Internet using HTTPS. Additionally, the web server shall have SHA-2 certificate support capability.
3. Database. System shall support any JDBC (Java DataBase Connectivity) compliant engine. This includes MS SQL, My SQL, Apache Derby, PostgreSQL, and Oracle.
4. The BMS system shall allow an unlimited number of concurrent users.
5. The BMS manufacturer shall provide all software and tools necessary to provide the following capabilities:
 - a. Create and/or edit any programming used in controllers.
 - b. Create and/or edit any graphics used in the system.
 - c. Software shall not be subscription based and be given to owner at time of turnover. If software is subscription based, manufacturer shall include 10 years of subscription service.
 - d. The owner shall have the ability to install software on a minimum of five (5) additional owner furnished computers without additional licenses or fees.
2. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

- a. Minimum graphics resolution shall be 1920 x1080 for display of detailed system graphics.
 - b. Floor Plan Graphics. Floor plan graphics shall be Scalable Vector Graphics (SVG) capable of allowing the floor plan graphic to dynamically size relative to the end user's monitor resolution.
 - c. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - d. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - e. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - f. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, GIF, or SVG. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in) or shall only require widely available no-cost plug-ins (such as Active-X or Adobe Flash).
6. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system to create and modify graphics that are saved in the same formats as are used for system graphics.
 7. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- E. System Applications. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard PC type personal computer with no limit on the number of copies that can be installed under the system license.
1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 2. Manual Controller Memory Download. Operators shall be able to download memory from the system database to each controller.

3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password.
4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
5. Video Training. Provide on-line video support to supplement on-line help assistance. Video content shall be relevant and support existing system documentation.
6. Security. Each operator shall be required to log on to the system with a username and password in order to view, edit, add, or delete data.
 - a. Operator Access. The username and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users. System Administrators shall also be able to vary and deny each operator's privileges based on the geographic location, such as the ability to edit operating parameters in Building A, to view but not edit parameters in Building B, and to not even see equipment in Building C.
 - b. Password Policy Rules. System administrator shall invoke policies for minimum password strength, including number of characters, special characters and numbers, upper and lower case, etc.
 - c. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time shall be user adjustable.
 - d. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
7. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
8. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as required by sequences of operation. Alarms shall be BACnet alarm objects and shall use BACnet alarm services. BMS system shall be capable of assigning alarm sources to categories such as HVAC Critical, or HVAC General. The BMS shall include at a minimum HVAC and FDD categories. BMS system shall allow user to create custom alarm categories.
9. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.

10. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send SMS text, and audibly annunciate.
11. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms and archive closed alarms to the workstation or web server hard.
12. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as required by the sequences of operations. Trends shall be BACnet trend objects. As a minimum, all physical points in the system shall be trended within the local controller (AAC, ASC, BC) for at least 277 samples per point. Selected points, as desired, shall be available for historical archiving within the server. The historical archiving capability cannot be less than 2 years.
13. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
14. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
15. Audit and Security Detail. All users accessing the system shall have their actions recorded. Information recorded shall include:
 - a. login/logout time and date
 - b. system modifications – with before and after values
 - c. ability to report user activity based on individual and/or date and time.
16. Standard Reports. Furnish the following standard system reports:
 - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 - 1) Alarm History.
 - 2) Trend Data. Operator shall be able to select trends to be logged.

17. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface. Operator shall be able to schedule reports to automatically run and be emailed to recipients on a recurring basis from the BMS system.
18. Logic Page. System shall allow operator to view all application software in real time for all controllers furnished and installed by BMS manufacturer.
19. Environmental Index. System shall monitor all occupied zones and compile an index that provides a numerical indication of the environmental comfort within the zone. As a minimum, this indication shall be based upon the deviation of the zone temperature from the heating or cooling setpoint. If humidity is being measured within the zone, then the environmental index shall be adjusted to reflect a lower comfort level for high or low humidity levels. Similarly, if carbon dioxide levels are being measured as an indication of ventilation effectiveness, then the environmental index shall be adjusted to indicate degraded comfort at high carbon dioxide levels. Other adjustments may be made to the environmental index based upon additional measurements. The system shall maintain a trend of the environmental index for each zone in the trend log. The system shall also compute an average comfort index for every building included in this contract and maintain trend logs of these building environmental indices. Similarly, the system shall compute the percentage of occupied time that comfortable conditions were maintained within the zones. Through the UI the user shall be able to add a weighting factor to adjust the contribution of each zone to the average index based upon the floor area of the zone, importance of the zone, or other static criteria.
20. Indoor Environmental Quality Index (IEQ)
 - a. System shall monitor up to ten building conditions and compile an index that provides a numerical indication of the overall building environmental quality and health. A graphical dashboard indicating each measured building condition name, a description of each measured building condition, the current value of each measured building condition, and the overall building IEQ value. In addition, an historical trend graph of the IEQ Index and/or individual health components shall also be displayed. The IEQ numerical value indication shall be 0-100 with 0 being the worst and 100 the best. The IEQ shall be calculated using an algorithm that aggregates all of the selected building conditions and allows the user to define the acceptable ranges for each monitored building condition. In addition, the user shall have the ability assign a weighting/importance factor to each building condition that determines the impact the monitored building condition has on the overall IEQ index calculation. The IEQ value graphical representation shall have the ability to display one of a minimum of four (4) colors based on the IEQ value and the user adjustable range for each color. The default IEQ ranges and colors shall be as follows:
 - 1) Less than 85 = Red
 - 2) 85 to 89.9 = Orange
 - 3) 90 to 94.9 = Yellow
 - 4) 95 to 100 = Green

- b. The system shall allow the user to select from one of the following ten building conditions:
 - 1) Temperature, average area
 - 2) Humidity, average area
 - 3) Carbon Dioxide, average area
 - 4) Volatile Organic Compounds, average area
 - 5) % Dirty Filters, % dirty filter switches
 - 6) % Occupied, of expected occupants
 - 7) Air Purifiers, Total counted purifiers
 - 8) % OA of Design, % Total OA cfm of buildings design.
 - 9) CFM per Person, Average outside air flow per occupant
 - 10) % Time Above minimum, % of time outside air dampers are above the minimum when occupied (average of all).
- 21. Time Lapse Graphic Replay. Operator shall be able to “replay” any graphic in the system to see how key values changed over an operator-selected period of time. Operator shall be able to select the starting date/time for this display and the end date/time or the display period. System shall then display the graphic as it would have looked at the beginning of that period, displaying key data, dynamic colors, etc. based upon values recorded at the start time. When the operator starts the replay the graphics and key values shall dynamically change to produce the effect of “fast forwarding” through the designated period of time. Once the system has been operational for at least 30 days, the contractor shall demonstrate that up to 24 hours of data from within the last 30 days can be replayed on any graphic page. Owner’s representative shall choose the graphic pages for this demonstration at the time of the demonstration.
- 22. Semantic Tagging. The BMS system shall include a semantic tagging engine that uses the Project Haystack library of descriptive tagging for building equipment and systems used in the BMS. The Project Haystack naming tags used by the BMS shall be a library that includes a comprehensive list of standard tag names to address common equipment, building systems, and device types. The library tag of names shall include at a minimum the tag names listed in ASHRAE Standard 223P.
- 23. Network Health Monitoring.
 - a. The BAS shall allow for monitoring of the network system health through the use of a remote cloud-based analytics platform. The BAS vendor shall provide to the owner a baseline report of the building network health at project completion and then once again at the end of the warranty period. The health monitoring application provides insights into the health of the BAS system for system maintenance and usage. This application will provide at a minimum the following information for the BAS network:
 - 1) BAS Server
 - a) Online status/availability
 - b) CPU and memory usage
 - c) JAVA Container Health: Memory usage patterns and allocation to overall server resources
 - 2) BACnet Controllers
 - a) Memory usage: Controller flash and database utilization
 - b) Critical errors: Controller and watchdog errors

- c) Network communications health: Transmit and receive patterns and identification of controllers that may be causing errors
 - 3) Network System Inventory
 - a) BAS Server software version
 - b) Controller driver versions
 - c) Controller upgrade requirements
 - b. At the completion of the warranty period, the owner shall have the option of continuing the remote network health monitoring service as part of an ongoing service contract negotiated with the BAS provider for an additional fee.
 - 24. Weather Data. The BMS system shall retrieve current weather conditions from a data source such as AccuWeather. This weather information shall be displayed on a graphic page and be capable for use in control logic.
- F. Workstation Application Editors. Each PC or browser workstation shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controllers panels
- 1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
 - 2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.
 - 3. Custom Application Programming. Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language. Language shall be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.
 - b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
 - c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
 - d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust

each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.

- e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
- g. Variables. Operator shall be able to use variable values in program conditional statements and mathematical functions.
 - 1) Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
 - 2) System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.

2.4 CONTROLLER SOFTWARE

- A. All controller software applications shall reside and operate in the system controllers.
- B. All application software in controllers furnished by BMS manufacturer shall be editable through operator workstation, web browser interface, or workstation.
- C. Each controller furnished by BMS manufacturer shall have all of its local on board software applications backed up and saved to the BMS web server. In the event of a controller failure, the BMS server shall download backed up software applications to replacement controller. Controllers furnished by others and integrated into the BMS are not required to be backed up to BMS server.
- D. Furnish the following applications for building and energy management:
 - 1. System Security.
 - 2. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
 - 3. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - 4. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance.

- Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
5. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
 6. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
 7. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.
 8. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.
 9. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
 10. Demand Limiting.
 - a. The demand-limiting program shall monitor building power consumption from a building power meter (provided by others) which generates pulse signals or a BACnet communications interface. An acceptable alternative is for the system to monitor a watt transducer or current transformer attached to the building feeder lines.
 - b. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in sequences of operation. When demand drops below adjustable levels, system shall restore loads as specified.
 11. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in sequences of operations.
 12. Sequencing. Application software shall sequence each piece of equipment as required by the specified sequences of operations.
 13. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.
 14. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
 15. Energy Calculations.
 - a. The system shall accumulate and convert instantaneous power (kW) or flow rates (gpm) to energy usage data.
 - b. The system shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
 16. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

17. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.
18. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as required by Sequence of Operations.
19. Fault Detection and Diagnostics (FDD). The system shall follow NIST and ASHRAE standards for enhanced monitoring and alarming. The FDD shall reside in the controller and be integral to the programming. Overlay software for primary FDD reporting is not acceptable. FDD capabilities shall include diagnostics for: Simultaneous Heating and Cooling; Continuous Operation; Fraction of Outdoor Air; Analog Output Cycling; Discrete Output Cycling; Sensor Failures; and Run Requests Analytics. These FDD alarms must be fully programmed, configured and active within the system. It is not acceptable for the system to have simply have the capability for FDD alarming, the alarming must be fully functional. The alarms shall be categorized and displayed on the BMS system. The FDD alarms shall be categorized into one of the following four categories:
 - a. FDD Comfort
 - b. FDD Critical
 - c. FDD Energy
 - d. FDD Maintenance

2.5 CONTROLLERS

- A. General. Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance as specified by system performance. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of communicating actuators, communicating sensors, BACnet Smart Actuators, and BACnet Smart Sensors
- B. BACnet.
 1. Building Controllers (BCs): Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
 2. Advanced Application Controllers (AACs): Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
 3. Smart Actuators (SAs): An actuator which is controlled by a network connection rather than a binary or analog signal (0-10v, 4-20mA, relay, etc.). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.

4. Smart Sensors (SSs): A sensor which provides information to the BAS via network connection rather than a binary or analog signal (0-10000 ohm, 4-20mA, dry contact, etc.). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
 5. BACnet Communication.
 - a. Each controller residing on the ethernet data link shall be capable of providing BACnet/SC capability as described in the above Communication Section.
 - b. Building Controllers (BC). Each BC shall connect to a network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol using BACnet/IP or BACnet/SC. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - c. Each AAC shall connect to a network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol using BACnet/IP or BACnet/SC.
 - d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.
- C. Security.
1. Provide BACnet firewall capability, as defined in the BACnet standard.
- D. Building Controllers (BC)
1. Communication
 - a. Network Connection. Controller shall support a single point ethernet connection.
 - b. Ethernet Port. Provide one (1) Gig-E port capable of full duplex communication up to 1000 Mbps
 - c. Service Port. Provide one (1) ethernet port for connection to a Portable Operator's Terminal.
 - d. Serial Port. Provide two (2) serial ports for communication to serial BACnet or serial Modbus networks.
 - e. Signal Management. BC shall have the ability to manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
 - f. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
 - g. Stand-Alone Operation. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All

- I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.
2. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - a. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at 29°C to 60°C (20°F to 140°F).
 - b. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
 3. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
 4. Real-time Clock. Controller shall have a real-time clock to keep track of time in the event of a power failure for up to three (3) days.
 5. Memory
 - a. Controller memory shall support operating system, database, and programming requirements.
 - b. Each BC shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
 - c. Each BC shall have 16 GBs eMMC flash memory and 256 MB DDR3 DRAM.

E. Advanced Application Controllers (AAC)

1. Communication
 - a. Network Connection. Controller shall support a single point ethernet connection or a daisy-chained ethernet connection using the Spanning Tree Protocol (STP).
 - b. Ethernet Port. Provide two (2) 10/100 Base T ethernet ports with ethernet switching capability.
 - c. Service Port. Provide one (1) USB port for connection to a Portable Operator's Terminal or a display.
 - d. Stand-Alone Operation. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.
2. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - a. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at 29°C to 60°C (20°F to 140°F).
 - b. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

3. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
 4. Real-time Clock. Controller shall have a real-time clock to keep track of time in the event of a power failure for up to three (3) days.
 5. Memory
 - a. Controller memory shall support operating system, database, and programming requirements.
 - b. Each AAC shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
 - c. Each AAC shall have 4 GBs eMMC flash memory and 256 MB DDR3 DRAM.
- F. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
- G. Transformer. Power supply shall be fused or current limiting and shall be rated at a minimum of 125% of controller power consumption.

2.6 INPUT AND OUTPUT INTERFACE

- A. General. Hard-wire input and output points to BCs, AACs, or ASCs.
- B. Protection. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.
- C. Binary Inputs. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.
- E. Analog Inputs. Analog inputs shall monitor low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual)

switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

- H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.
- J. Operator Displays. Provide a 4", 7", or 10" operator display as noted on drawings for each controller. Operator displays shall be as follows:
 - 1. Physical Display. The display shall be a fully customizable capacitive multi-touch color display unit with the following minimum capabilities:

	<u>4" Display</u>	<u>7" Display</u>	<u>10" Display</u>
Display Size(diagonal)	4"	7"	10.1"
Resolution (pixels)	480 x 272	1024 x 600	1280 x 800
Brightness (cd/m2)	400	320	350
Contrast Ratio	1000:1	1000:1	800:1

- 2. Power. Display shall be powered by 24Vdc power.
- 3. Maximum Colors: The display shall provide 8-bit capability for 16.7 million colors
- 4. Touch Screen: The screen shall be a capacitive multi-touch screen using Projected Capacitive Touch (PCAP) technology.
- 5. Environmental: The display shall operate in conditions of -4° to 140°F with a front IP65 water and dustproof rating and a rear IP20 water and dustproof rating.
- 6. Communication: The following communication ports shall be provided:
 - a. Ethernet LAN port
 - b. Serial Port
 - c. USB Port
 - d. USB OTG Port
- 7. System/Memory: The display shall use the Android operating system and shall have a dual core processor, 1GB LPDDR3 RAM system memory, 8GB on-board eMMC flash memory, 365-day real time clock/calendar with time and date maintained for a minimum of 72 hours after loss of power (at room temperature).
- 8. User Interface: Display shall provide the following user interface capabilities:
 - a. Multi-level password protection for security
 - b. Access virtually any point in the controller
 - c. View trends
 - d. View and edit BACnet time schedules.
 - e. Change setpoints

- K. Communicating Actuators. Controller shall be capable of using hardwired actuators or an option of using communicating actuators connected to a dedicated actuator network port. The communicating actuator network shall be capable of the following:
 - 1. The controller shall be able to communicate the actuator position command through the actuator network.
 - 2. The actuator shall be to provide the actuator feedback position to the controller through the actuator network.
- L. Communicating Sensors. Controller shall be capable of using hardwired sensors or an option of using communicating sensors connected to a dedicated sensor network port. The dedicated sensor network shall be capable of monitoring the following communicating sensors:
 - 1. Temperature
 - 2. Humidity
 - 3. CO2
 - 4. VOC
 - 5. Occupancy
 - 6. Motion

2.7 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA listed.
- B. Power Line Filtering.
 - 1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater

- d. Common mode noise attenuation of 150 dB or greater at 40–100 Hz

2.8 LOCAL CONTROL PANELS.

- A. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
- B. Interconnections between internal and face-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/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
- C. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.9 WIRING AND RACEWAYS

- A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
- B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and at the expense of—this contractor.

3.2 PROTECTION

- A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.

- B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

- A. Site.

- 1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
- 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

- B. Test and Balance.

- 1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
- 2. The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
- 3. In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
- 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.

- C. Life Safety.

- 1. Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock smoke detectors to air handlers for shutdown as specified in sequences of operation.
- 2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. Interlock smoke dampers to air handlers as specified in sequences of operation.
- 3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 28.

- D. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:

1. All communication media and equipment shall be provided as specified in Section 23 09 23 Article 2.2 (Communication).
2. Each supplier of a control's product is responsible for the configuration, programming, start up, and testing of that product to meet the sequences of operation described in Section 23 09 93
3. The contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install equipment in readily accessible locations as defined by Chapter 1 Article 100 Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 Article 1.8 (Codes and Standards).
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- C. Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.6 WIRING

- A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification. Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.

- B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
- C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.
- D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.
- E. All wiring in mechanical, electrical, or service rooms – or where subject to mechanical damage – shall be installed in raceway at levels below 3 m (10ft).
- F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes 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 and transformers).
- G. Do not install wiring in raceway containing tubing.
- H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.
- I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.
- M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- O. Size of raceway and size and type of wire shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- P. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- Q. Use color-coded conductors throughout with conductors of different colors.
- R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

- S. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g. steam pipes or flues).
- T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- U. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
- V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.
- W. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- X. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes and ends not terminating in boxes shall have bushings installed.

3.7 COMMUNICATION WIRING

- A. The contractor shall adhere to the items listed in the Wiring" article in Part 3 of the specification.
- B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to manufacturer's instructions.
- G. All runs of communication wiring shall be unspliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.

- I. Grounding of coaxial cable shall be in accordance with NEC regulations article on “Communications Circuits, Cable, and Protector Grounding.”
- J. BACnet ARCnet or MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
 - 1. ARCnet
 - a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 nominals. Distributed capacitance between conductors shall be less than 12.5 pF per foot (41 pF per meter.)
 - b. The maximum length of an ARCnet segment is 610 meters (2000 ft) with AWG 22 cable.
 - c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - d. An ARCnet network shall have no T connections.
 - 2. MS/TP
 - a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 - b. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485
 - c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - d. An MS/TP EIA-485 network shall have no T connections.

3.8 FIBER OPTIC CABLE

- A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer’s specifications.
- B. All cabling and associated components shall be installed in accordance with manufacturers’ instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3.9 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer’s recommendations.
- B. Mount sensors rigidly and adequately for environment within which the sensor operates.

- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.
- D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.
- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m (1 ft) of sensing element for each 1 m² (1 ft²) of coil area.
- G. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 3 m (10 ft) downstream.
- H. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- I. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- J. Differential Air Static Pressure.
 - 1. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - 3. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - 4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - 5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 - 6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.
- K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

- L. Install humidity sensors for duct mounted humidifiers at least 3 m (10 ft) downstream of the humidifier. Do not install filters between the humidifier and the sensor.

3.10 FLOW SWITCH INSTALLATION

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch according to manufacturer's instructions.

3.11 ACTUATORS

- A. General. Mount and link control damper actuators according to manufacturer's instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/ Electronic
 - 1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.
 - 2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.12 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the control system.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows.
 - a. C A U T I O N: This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.
- B. Permanent warning labels shall be affixed to all motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.

2. Warning labels shall read as follows.

- a. C A U T I O N: This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.13 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 5 cm (2 in.) of termination with control system address or termination number.
- B. All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.
- D. Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- E. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- F. Identify room sensors related to terminal boxes or valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- H. Identifiers shall match record documents.

3.14 CONTROLLERS

- A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in sequences of operations.

3.15 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging
- B. Point Naming. Coordinate with owner for point naming conventions. Name points as shown on the equipment points list provided with each sequence of operation or as directed by owner. If character limitations or space restrictions make it advisable to shorten the name, abbreviations as coordinated with owner may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- C. Software Programming.

1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a. Text-based:
 - 1) Must provide actions for all possible situations.
 - 2) Must be modular and structured.
 - 3) Must be commented.
 - b. Graphic-based:
 - 1) Must provide actions for all possible situations.
 - 2) Must be documented.
 - c. Parameter-based:
 - 1) Must provide actions for all possible situations.
 - 2) Must be documented.

D. Operator Interface.

1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List or sequence of operations.
2. The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.16 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.

1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.17 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration.

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.

3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
 - c. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - d. Interface to the building fire alarm system.
 - e. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance.

1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.18 CLEANING

- A. The contractor shall clean up 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. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.19 TRAINING

- A. Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.
- B. Training shall enable students to accomplish the following objectives.
 1. Day-to-day Operators:
 - a. Proficiently operate the system
 - b. Understand control system architecture and configuration.
 - c. Understand DDC system components.
 - d. Understand system operation, including DDC system control and optimizing routines (algorithms)
 - e. Operate the workstation and peripherals.

- f. Log on and off the system.
 - g. Access graphics, point reports, and logs
 - h. Adjust and change system set points, time schedules, and holiday schedules.
 - i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - j. Understand system drawings and Operation and Maintenance manual.
 - k. Understand the job layout and location of control components.
 - l. Access data from DDC controllers and ASCs
 - m. Operate portable operator's terminals.
2. Advanced Operators:
- a. Make and change graphics on the workstation.
 - b. Create, delete, and modify alarms, including annunciation and routing of these.
 - c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals.
 - d. Create, delete, and modify reports.
 - e. Add, remove, and modify system's physical points.
 - f. Create, modify, and delete programming.
 - g. Add panels when required.
 - h. Add operator interface stations.
 - i. Create, delete, and modify system displays, both graphical and others
 - j. Perform DDC system field checkout procedures.
 - k. Perform DDC controller unit operation and maintenance procedures.
 - l. Perform workstation and peripheral operation and maintenance procedures.
 - m. Perform DDC system diagnostic procedures.
 - n. Configure hardware including PC boards, switches, communication, and I/O points.
 - o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware.

- p. Adjust, calibrate, and replace system components.
- 3. System Managers/Administrators:
 - a. Maintain software and prepare backups.
 - b. Interface with job-specific, third-party operator software
 - c. Add new users and understand password security procedures.
- C. Organize the training into sessions or modules for the three levels of operators listed above. (Day-to-Day Operators, Advanced Operators, System Managers and Administrators). Students will receive one or more of the training packages, depending on knowledge level required.
- D. Provide course outline and materials according to the "Submittals" article in Part 1 of this specification. Provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained and experienced in presenting this material.
- F. Classroom training shall be done using a network of working controllers' representative of installed hardware.

3.20 SEQUENCES OF OPERATION

- A. See Section 23 Sequences of Operation.

3.21 CONTROL VALVE INSTALLATION

- A. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.
- B. 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 position.
- C. Valves shall be installed in accordance with the manufacturer's recommendations.
- D. 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.
- E. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.
- F. Provide tags for all control valves indicating service and number. Tags shall be brass, 1.5 inch in diameter, with ¼ inch high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.

3.22 CONTROL DAMPER INSTALLATION

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- B. 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 $\frac{1}{4}$ in. larger than damper dimensions and shall be square, straight, and level.
- C. 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 in.) of each other.
- D. 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.
- E. Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- 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.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.23 SMOKE DAMPER INSTALLATION

- A. The contractor shall coordinate all smoke and smoke/fire damper installation, wiring, and checkout to ensure that these dampers function properly and that they respond to the proper fire alarm system general, zone, and/or detector trips. The contractor shall immediately report any discrepancies to the engineer no less than two weeks prior to inspection by the code authority having jurisdiction.
- B. Provide complete submittal data to controls system subcontractor for coordination of duct smoke detector interface to HVAC systems.

3.24 DUCT SMOKE DETECTION

- A. Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."
- B. This Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

3.25 PACKAGED EQUIPMENT CONTROLS

- A. General. The electronic controls packaged with any equipment furnished under this contract shall communicate with the building direct digital control (DDC) system. The DDC system shall communicate with these controls to read the information and change the control setpoints as shown in the points list, sequences of operation, and control schematics. The information to be communicated between the DDC system and these controls shall be in the standard object format as defined in ANSI/ASHRAE Standard 135 (BACnet). Controllers shall communicate with other BACnet objects on the internetwork using the Read (Execute) Property service as defined in Clause 15.5 of Standard 135.
- B. Distributed Processing. The controller shall be capable of stand-alone operation and shall continue to provide control functions if the network connection is lost.
- C. I/O Capacity. The controller shall contain sufficient I/ O capacity to control the target system.
- D. The Controller shall have a physical connection for a laptop computer or a portable operator's tool.
- E. Environment. The hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 - 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- F. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- G. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 30 days.
- H. Power. Controller shall be able to operate at 90% to 110% of nominal voltage rating .
- I. Transformer. Power supply for the Controller must be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

3.26 START-UP AND CHECKOUT PROCEDURES

- A. Start up, check out, and test all hardware and software and verify communication between all components.
 - 1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 2. Verify that all analog and binary input/output points read properly.
 - 3. Verify alarms and interlocks.

4. Verify operation of the integrated system.

END OF SECTION 23 0900

SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions, and Division 1 Specification Sections apply to all Sections of Division 26.
- B. The requirements listed under General Conditions and Supplementary Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 26 and form a part of the contract.

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements of electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
 - 1. Submittals
 - 2. Coordination Drawings
 - 3. Record Documents
 - 4. Maintenance Manuals
 - 5. Rough-Ins
 - 6. Electrical Installations
 - 7. Cutting and Patching

1.3 ELECTRICAL DIVISION INDEX

Section 26 0500	Common Work Results for Electrical
Section 26 0502	Electrical Demolition
Section 26 0519	Low Voltage Electrical Power Conductors and Cables
Section 26 0526	Grounding and Bonding for Electrical Systems
Section 26 0529	Hangers and Supports for Electrical Systems
Section 26 0533	Raceway and Boxes for Electrical Systems
Section 26 0550	Installation Coordination
Section 26 0553	Identification for Electrical Systems
Section 26 0573	Power System Analysis
Section 26 2726	Wiring Devices

1.4 CODES AND PERMITS

- A. Perform electrical work in strict accordance with the applicable provisions of the National Electrical Code, Latest Edition; National Electric Safety Code, Latest Edition; the International Building Code, 2015 as adopted and interpreted by the State of Texas, City of Houston, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

- B. Secure and pay for all permits necessary for performance of the work. Pay for all utility connections unless otherwise specified herein.
- C. The following lists applicable codes and standards that, as a minimum, shall be followed.

Applicable county and state electrical codes, laws and ordinances.

National Electrical Manufacturer's Association Standards

National Electrical Code

National Electrical Safety Code

Underwriters Laboratories, Inc. Standards

American National Standards Institute

American Society for Testing Materials Standards

Standards and requirements of local utility companies

National Fire Protection Association Standards

Institute of Electrical and Electronics Engineers Standards

Insulated Cable Engineers Association

Occupational Safety and Health Act

Uniform Fire Code

Americans with Disabilities Act

Commercial and Industrial Insulation Standards (MICA)

1.5 RECORD DRAWINGS

- A. Maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all electrical work, and in particular, where changes were made during construction. Use red color to indicate additions or corrections to prints, green color to indicate deletions, and yellow color to indicate items were installed as shown. Keep record drawings accurate and up to date throughout the construction period. Record drawings may be reviewed and checked by the Engineer during the construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set. Transmit drawings to the Engineer at the conclusion of the project for delivery to the Owner's Representative.

1.6 QUALIFICATIONS

- A. All electricians shall be skilled in their respective trade.

1.7 SUBSTITUTIONS

- A. Identification of Division 26 equipment, fixtures, and materials listed within this Specification and in the Equipment Schedules on the drawings, which are identified by manufacturer's name, trade name, and/or model numbers are generally not meant to give preference to any manufacturer but are provided to establish the design requirements and standards.
- B. Equipment submitted for substitution must fit the space conditions leaving adequate room for maintenance around all equipment. A minimum of 36 inches, or more if required by Code, must be maintained clear in front of all electrical panels, starters, gutters, or other electrical apparatus. Submit drawings showing the layout, size and exact method of interconnection of conduit, wiring and controls, which shall conform to the manufacturer's recommendations and these specifications. The scale of these drawings shall be scale of Contract Drawings. The Contractor shall bear the excess costs, by any and all crafts, of fitting the equipment into the space and the system designated. Where additional labor or material is required to permit equipment submitted for substitution to function in an approved manner, this shall be furnished and installed by the Contractor without additional cost to the Owner.
- C. Equipment submitted for substitution shall be approved in writing by the Owner or his representative and shall be accompanied by the following:
 - 1. A sample of each item submitted for substitution shall accompany the submittal.
 - 2. Provide a unit price quotation with each item intended for substitution. Include a unit price for the specified item and a unit price for the intended substitute item. Provide a total (per item) of the differential payback to the Owner should the intended substitute item be approved as equivalent to that which is specified.
 - 3. Reimburse the Owner for the Architect/Engineer's additional services required to review and process substitutions.
- D. Substitutions shall be approved in writing by the Owner or his representatives. The determination of the Owner shall be final.

1.8 HAZARDOUS CONDITIONS

- A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.9 DEFINITIONS

- A. Definitions of terms will be found in the National Electrical Code.
- B. Whenever a term is used in this Specification, which is defined in the Code, the definition given will govern its meaning in this Specification.
- C. Whenever a technical term is used which does not appear in the Code, the definition to govern its meaning in these Specifications will be found in the Standard Dictionary of Electrical and Electronic Terms, published by the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08855-1331.
- D. "Provide" means furnish, install, connect and test unless otherwise noted.

1.10 SUBMITTALS

- A. The Contractor shall submit submittal brochures of equipment, fixtures and materials to be furnished under Division 26.
- B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.
- C. Install equipment in accordance with the manufacturer's recommendations. Provide accessories and components for optimum operation as recommended by the manufacturer.
- D. Costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.
- E. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification from the Architect/Engineer that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter to the Architect/Engineer.
- F. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including a minimum of 3 feet clear in front of all electrical equipment and panels as defined by the National Electrical Code. Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.
- G. Shop Drawings: Unless the following information is included, shop drawings will be returned unchecked:
 - 1. Cover sheet for each submittal, listing equipment, products, and materials, and referencing data and sections in Specifications and drawings. Clearly reference project name and provide space for a review stamp.
 - 2. Cover sheet shall clearly identify deviations from specifications, and justification.
 - 3. Include all related equipment in a single submittal to allow complete review. Similar equipment may be submitted under a common cover sheet.
 - 4. Size, dimensions, and weight of equipment.
 - 5. Equipment performance under specified conditions, not a copy of scheduled data on drawings.

6. Indicate actual equipment proposed, where data sheets indicate more than one (1) device or equipment.
 - H. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.
 - I. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted, for review by the Engineer, with the shop drawing submittals of the substituted. Failure to comply with this requirement will result in the shop drawings being returned unchecked.
 - J. Submittals and one (1) resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.
 - K. The Contractor shall submit a digital copy of submittal brochures for review. Brochures shall be submitted within thirty (30) days after contract award.
- 1.11 MAINTENANCE MANUALS
- A. Prepare maintenance manuals in accordance with Division 1, Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:
 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.
- 1.12 USE OF CADD FILES
- A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.
 - B. The Engineer shall be compensated for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc.
 - C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.13 DRAWINGS AND SPECIFICATIONS

- A. Electrical drawings are diagrammatic but shall be followed as closely as actual construction and work of the other sections shall permit. Size and location of equipment is drawn to scale wherever possible. Do not scale from electrical drawings.
- B. Drawings and specifications are for the assistance and guidance of the Contractor. Exact locations, distances, and levels will be governed by the building. The Contractor shall make use of data in all the Contract Documents to verify information at the building site.
- C. In any case where there appears to be a conflict between that which is shown on the electrical drawings, and that shown in any other part of the Contract Documents, the Contractor shall notify and secure directions from the Architect.
- D. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification. Do not proceed with work without direction.
- E. The Architect shall interpret the drawings and the specifications. The Architect's interpretation as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished there under shall be accepted as final and conclusive.
- F. In the case of conflicts not clarified prior to the bidding deadline, use the costliest alternative (better quality, greater quantity, and larger size) in preparing the bid. A clarification will be issued to the successful bidder as soon as feasible after the award and, if appropriate, a deductive change order will be issued.
- G. Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras indicated on the drawings or in the specifications.
- H. Investigate structural and finish conditions and arrange work accordingly. Provide all fittings, equipment, and accessories required for actual conditions.

1.14 SIMILAR MATERIALS

- A. All items of a similar type shall be products of the same manufacturer.
- B. Contractor shall coordinate among suppliers of various equipment to assure that similar equipment type is product of the same manufacturer.
- C. Examples of similar equipment types include but are not limited to:
 - 1. Power Circuit Breakers
 - 2. Enclosed Case Circuit Breakers
 - 3. Panelboards
 - 4. Disconnects

1.15 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.16 GUARANTEE-WARRANTY

- A. The following guarantee is a part of the specifications and shall be binding on the Contractor:

"The Contractor guarantees that this installation is free from ALL defects. He agrees to replace or repair any part of the installation which may fail within a period of one (1) year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date to be determined in writing by means of issuing a 'Certificate of Substantial Completion', AIA Form G704."

- B. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

- A. All equipment and materials shall be new and shall be the standard product of manufacturers regularly engaged in the production of electrical equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

2.2 ALTITUDE RATINGS

- A. Unless otherwise noted, all specified equipment capacities are for an altitude of **3000** feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 EQUIPMENT REQUIREMENTS

- A. The electrical requirements for equipment specified or indicated on the drawings are based on information available at the time of design. If equipment furnished for installation has electrical requirements other than those indicated on the electrical drawings, make all adjustments to wire and conduit size, controls, over current protection, and installation as required to accommodate the equipment supplied. Delineate all adjustments to the drawings reflecting the electrical system in a submittal to the Contract Administrator immediately upon knowledge of the required adjustment.
- B. Approved Equipment and Conductors: ALL equipment and conductors shall be listed and labeled by a nationally recognized testing laboratory (NRTL). The NRTL shall be listed by the federal occupational safety and health administration.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

- A. Coordinate all work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

- A. The electrical drawings show the general arrangement of all lighting, power, special systems, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents shall be considered as part of the work. Coordinate with architectural, mechanical, and structural drawings. Because of the small scale of the electrical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Provide all fittings, boxes, and accessories as may be required to meet actual conditions. Should conditions necessitate a rearrangement of equipment, such departures and the reasons therefore, shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No changes shall be made without the prior written approval. All changes shall be marked on record drawings.
- B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.
- C. Installation of all equipment shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearance, as defined by the National Electrical Code (NEC).
- D. The installation of all concealed electrical systems shall be carefully arranged to fit within the available space without interference with adjacent structural and mechanical systems.

3.3 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical system, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with all other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in all other building components during progress of construction, to allow for electrical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum clearance possible.
 - 7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 - 8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
 - 9. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

10. Install access panel or doors where units are concealed behind finished surfaces.
11. Install systems, materials, and equipment giving right-of-way priority to systems requiring installation at a specified slope.

3.4 FIELD MEASUREMENTS

- A. No extra compensation shall be claimed or allowed due to differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work and shall report any work which must be corrected. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the electrical work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor.

3.5 EQUIPMENT SUPPORT

- A. Provide support for equipment to the building structure. Provide all necessary structures, inserts, sleeves, firestops and hanging devices for installation of equipment. Coordinate installation of devices. Verify with the Architect that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.6 PAINTING

- A. All finish painting of electrical systems and equipment will be under "Painting," unless equipment is hereinafter specified to be painted.
- B. All equipment shall be provided with factory applied standard finish, unless otherwise specified.
- C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished to the satisfaction of the Engineer.

3.7 PROTECTION OF MATERIALS AND EQUIPMENT

- A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.
- B. All items of electrical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building or shall be otherwise protected from the weather in a suitable manner approved by the Engineer.
- C. The Contractor shall provide protection for all work and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Engineer prior to such storage.
- D. Conduit openings shall be closed with caps or plugs or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Engineer.

3.8 EXCAVATION

- A. Provide all excavation, trenching and backfilling required.
- B. Slope sides of excavations to comply with codes and ordinances. Shore and brace as required for stability of excavation.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.11 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturer's printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
- C. Firestopping Sealant: Provide sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide firestops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.12 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

3.13 CUTTING AND PATCHING

- A. Perform cutting and patching in accordance with Division 1, Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Remove and replace defective Work.
 - b. Remove and replace Work not conforming to requirements of the Contract Documents.
 - c. Remove samples of installed Work as specified for testing.
 - d. Install equipment and materials in existing structures.
 - e. Upon written instructions from the Contracting Officer, uncover and restore Work to provide for Contracting Officer observation of concealed Work.
 2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
 3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
 5. During cutting and patching operations, protect adjacent installations.
 6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers.

3.14 MANUFACTURER'S INSTRUCTIONS

- A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall submit such conflicts to the Engineer who shall make such compromises as he deems necessary and desirable.

3.15 CONCRETE BASES AND HOUSEKEEPING PADS

- A. Install concrete bases and housekeeping pads under all freestanding electrical equipment unless otherwise noted.
- B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all anchor bolts, etc. Coordinate weight of concrete bases and housekeeping pads with the structural engineer.
- C. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with Carborundum block after stripping forms. Tops shall be level. Provide dowel rods or other required material in floor for lateral stability and anchorage.
- D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1" larger than bolt diameter. Anchor bolts shall be high strength steel J shape. Anchor bolt design shall be arranged and paid for by the Contractor.

3.16 TESTS

- A. All tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the **[Architect] [Engineer] [Owner's Representative]** one week in advance of all tests. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.17 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall furnish the complete operating and maintenance instructions covering all units of electrical equipment herein specified together with parts lists. Furnish two (2) copies of all the literature; each shall be suitably bound in loose leaf book form and one electronic version.
- B. Operating and maintenance manuals as required herein shall be submitted for review not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.
- C. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the electrical systems and equipment for a period of up to five (5) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative in the operations, adjustment, and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

3.18 CERTIFICATIONS

- A. Before receiving final payment, certify in writing that all equipment furnished, and all work done is in compliance with all applicable codes mentioned in these specifications. Submit certifications and acceptance certificates to the Engineer, including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.19 INTERRUPTING SERVICES

- A. The Contractor shall coordinate the installation of all work within the building in order to minimize interference with the operation of existing building electrical telephone, fire alarm, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written review.

3.20 OPERATION PRIOR TO ACCEPTANCE

- A. Operation of equipment and systems installed by the Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.
- B. Operation of equipment and systems installed by the Contractor, for the benefit of the Contractor, except for the purposes of testing and balancing will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.21 SITE VISITS AND OBSERVATION OF CONSTRUCTION

- A. The Architect/Engineer will make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation by the Architect/Engineer however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities, nor shall the Architect/Engineer have authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION 26 0500

DIVISION 26 SUBSTITUTION REQUEST FORM (SRF)TO: RAMIREZ-SIMON ENGINEERING, LLCPROJECT: WILLIAMSON COUNTY ESOC DATA CENTER COOLING UPGRADES

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? ☐ YES ☐ NO
If YES, explain: _____2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐

3. List differences between proposed substitutions and specified item.

Specified Item

Proposed Substitution

_____4. Does substitution affect Drawing dimensions? YES ☐ NO ☐5. What affect does substitution have on other trades? _____
_____6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
If YES, explain: _____
_____7. Will substitution affect progress schedule? YES ☐ NO ☐
If YES, explain: _____
_____8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
If YES, explain: _____
_____9. Is substitution identical in appearance and function to specialized product? YES ☐ NO ☐

Submitting Firm: _____	Date: _____
Address: _____	
Signature: _____	Telephone: _____

For Engineer's Use Only

Accepted: _____ Not Accepted: _____ Received Too Late: _____

By: _____ Date: _____

Remarks: _____

CAD AGREEMENT**PROJECT:** WILLIAMSON COUNTY ESOC DATA CENTER COOLING UPGRADES

Contractor understands and acknowledges by signature below that by transferring BIM/CAD documents for contractor/subcontractor use, Ramirez Simon Engineering, LLC (RSE) disclaims all warranties and obligations or liabilities for damages, including, but not limited to, consequential damages arising from or in connection with the use or performance of the documents. Contractor shall use documents at contractor's sole risk and without liability, risk or legal expose to RSE. Documents are diagrammatic in nature developed to display the general scope of the project. It is the contractor's responsibility to verify dimensional requirements.

Contractor agrees to limit document distribution and use to only contractor employees or subcontractors on this project. Contractor shall not distribute documents to any other entities without written consent from RSE.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2: _____

Date: _____

SECTION 26 0502
DEMOLITION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions, and Division 1 Specification Sections apply to this Section.
- B. See Section 26 0500 for Common Work Results for Electrical.

1.2 SCOPE OF WORK

- A. Provide all material, equipment and labor as required to remove, relocate and/or reconnect all electrical work identified in these specifications and indicated on the drawings.

1.3 SUMMARY

- A. This Section includes limited scope, general construction materials and methods for application with electrical installations as follows:
 - 1. Selective demolition including:
 - a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
 - b. Dismantling electrical materials and equipment made obsolete by these installations.
 - 2. Excavation for underground utilities and services, including underground raceways.
 - 3. Miscellaneous metals for support of electrical materials and equipment.
 - 4. Nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment.
 - 5. Joint sealers for sealing around electrical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 - 6. Access panels and doors in walls, ceilings, and floors for access to electrical materials and equipment.

1.4 PROJECT CONDITIONS

- A. Conditions affecting selective demolition: The following project conditions apply:
 - 1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Conditions affecting excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
3. Existing utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
4. Remove existing underground utilities indicated to be removed.
 - a. Uncharted or incorrectly charted utilities: Contact utility owner immediately for instructions.
 - b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to Owner's Representative prior to utility interruption.
5. Use of explosives is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Verify field measurements and circuiting arrangements as shown on drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.
- D. Beginning of demolition means Contractor accepts existing conditions.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Disconnect and remove electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Coordinate utility service outages with Owner a minimum of [72] hours prior to outage.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing electrical services: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from the Owner's Representative at least [72] hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.2 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work under provisions of this section.
- B. Remove, relocate and extend existing installations to accommodate new construction. Recircuit

and reconnect all electrical lighting, outlets, and equipment not scheduled for removal that have become disconnected due to demolition work.

- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit serving them is removed. Provide blank cover for abandoned outlets which are not removed. Provide blank cover for abandoned outlets which are not removed.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.
- I. Repair adjacent construction and finishes damaged during demolition and extension work. Any damage to building, piping or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.
- J. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.
- L. Removal and replacement of ceiling tile(s) to perform work operations shall be the responsibility of the Contractor. The Contractor shall be responsible for replacement of any ceiling tiles or framework that may become damaged at no cost to the Owner.
- M. Housekeeping Pads and Equipment Foundations: Remove for all equipment removal. Backfill as required, compact to 95 percent modified Proctor density, and pour floor slab or resurface floor to match existing.
- N. Conduit in Concealed Locations: Remove conductors, cap both ends of conduit, and label conduit as "Abandoned" at both ends. Where conduit runs below grade, cap both ends of conduit and abandon in place. Where conduit runs below floor slab, additionally, chip out concrete around conduit, remove conduit to bottom of slab level, and patch floor to match existing.

3.3 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

- C. Luminaries: Remove existing luminaries for cleaning, as indicated on drawings. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.
- D. Materials and equipment to be salvaged: Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- E. Disposal and cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

3.4 INSTALLATION

- A. Install relocated materials and equipment under the provisions of this section.

3.5 ITEMS SALVAGED TO OWNER

- A. Items salvaged to Owner are as indicated on drawings. Move and store in dry location as directed. Refuse materials and items not salvaged shall be removed from the site and legally disposed of.

END OF SECTION 26 0502

SECTION 26 0519
LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 volts and less.

1.3 SUBMITTALS

- A. Field test reports indicating and interpreting test results relative to compliance with performance requirements of testing standard.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section "Quality Control Services," an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association (NETA).

- 1. Testing Agency's Field Supervisor Qualifications: A person currently certified by the NETA National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

- 1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.

- C. Comply with NFPA 70 National Electrical Code for components and installation.

1.5 SEQUENCING AND SCHEDULING

- A. Coordination: Coordinate layout and installation of cable with other installations.
- B. Revise locations and elevations from those indicated as required to suit field conditions.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wire and cable according to NEMA WC-26.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wires and Cables:
 - a. Brand-Rex, a Leviton Company.
 - b. General Cable.
 - c. Southwire Co.
 - 2. Connectors for Wires and Cables:
 - a. AMP, Inc, a TE Connectivity Company.
 - b. Anderson Power Products, An Ideal Company.
 - c. Electrical Products Division, 3M Corporation.
 - d. O-Z Gedney, an Emerson Industrial Automation company.

2.2 BUILDING WIRES AND CABLES

- A. UL listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Applications" Article.
- B. Rubber Insulation: Comply with NEMA WC 3.
- C. Thermoplastic Insulation: Comply with NEMA WC 5.
- D. Cross-Linked Polyethylene Insulation: Comply with NEMA WC 7.
- E. Ethylene Propylene Rubber Insulation: Comply with NEMA WC 8.
- F. Conductor Material: soft-drawn annealed copper. Specify as follows:
 - 1. General Power and lighting: Minimum size #12 AWG: solid conductors for #12 AWG and #10 AWG and stranded conductors for #8 AWG and larger.
 - 2. Stranded conductors for connections to motors, generators, and other vibrating equipment (all sizes).
 - 3. Control (field installed): Minimum size #14 AWG; stranded conductors all sizes.
- G. Outdoor Conductor Material: 600V Type XHHW-2 insulated copper conductors; above and below grade.

2.3 CONNECTORS AND SPLICES

- A. UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated. Select to comply with Project's installation requirements and as specified in Part 3 "Applications" Article.
- B. Use listed motor lead splicing kits for insulating and sealing bolted pigtail and in-line connections in terminal boxes of motors rated 1HP and larger.
- C. Provide splicing kits that include a 1 kV dielectric rated sleeve with thick walls to resist abrasion and puncture.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceways and building finishes to receive wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Feeders: Type THHN/THWN.
- B. Branch Circuits: Type THHN/THWN, in raceway.
- C. Class 1 Control Circuits: Type THHN/THWN, copper conductor, in raceway.
- D. Class 2 Control Circuits: Type THHN/THWN, in raceway.
- E. Ampacity: Use 60°C rating only for sizes #14 AWG through #1 AWG unless otherwise noted.

3.3 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and the NECA "Standard of Installation."
- B. Do not install building wiring that is listed for dry/indoor locations-only until the building is dried-in.
- C. Do not use multiwire branch circuits. Provide a dedicated grounded (neutral) conductor for each branch circuit that requires a neutral.
- D. Metal-Clad Cable or MC Cable may be used for light switches and receptacle whips of no more than 25 ft and as follows:
 - 1. Only in general occupancy rooms, such as offices, classrooms and conference rooms. Do not use in Rooms such as Mechanical Rooms, Electrical Rooms, Laboratories, or any other high equipment rooms or laboratories.
 - 2. MC Cable must be installed to a minimum of NECA standards, additionally must be installed in straight runs with definite bends only and must be well secured. Well secured shall be no more than 1" deflection for straight runs and 3" of defection for bends at 3 lbs. of force.
- E. Remove existing wire from raceway before pulling in new wire and cable.
- F. Pull conductors into raceway simultaneously where more than one is being installed in same raceway.
 - 1. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation.
 - 2. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

- G. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
- H. Conductor Splices: In branch circuits and if kept to minimum. No splices in services or feeders.
 - 1. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
 - 2. Use splice and tap connectors that are compatible with conductor material.
- I. Wiring at Outlets: Install with at least 12 inches of slack conductor at each outlet.
- J. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.4 FIELD QUALITY CONTROL

- A. Testing: Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.1. Certify compliance with test parameters.
- B. Correct malfunctioning products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

END OF SECTION 26 0519

SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this section.

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For firms and persons specified in 'Quality Assurance' Article.
- C. Field Test Reports: Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the National Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the National Electrical Testing Association to supervise onsite testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 1. Comply with UL 467.
- C. Comply with NFPA 70; for overhead line construction and medium voltage underground construction, comply with IEEE C2.
- D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
1. Grounding Conductors, Cables, Connectors, and Rods:
 - a. Burndy; Part of Hubbell Electrical Systems.
 - b. Dossert; AFL Telecommunications LLC.
 - c. ERICO, Inc.
 - d. Fushi Copperweld Inc.
 - e. Galvan Industries, Inc.; Electrical Products Division, LLC.
 - f. Harger Lightning and Grounding.
 - g. ILSCO.
 - h. O-Z/Gedney; A Brand of the Emerson Electrical Co.
 - i. Robbins Lightning, Inc.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26, Section 26 0519, Low-Voltage Electrical Power.
- B. Equipment Grounding Conductors: Insulated with green colored insulation.
- C. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- D. Bare Copper Conductors: Comply with the following:
1. Solid Conductors: ASTM B3.
 2. Assembly of Stranded Conductors: ASTM B8.
 3. Tinned Conductors: ASTM B33.
- E. Copper Bonding Conductors: As follows:
1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 4. Tinned Bonding Jumper: Tinned copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted pressure type connectors, or compression type, copper or copper-alloy.

- C. Welded Connectors: Exothermic welded type, in kit form, and selected per manufacturer's written instructions.
- D. Irreversible Compression Connectors: In kit form, selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections or Irreversible Compression Connections: Use for connections to structural steel and for underground connections, except those at test wells.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Underground Grounding Conductors: Use bare tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250 for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install insulated equipment grounding conductors in all feeders and circuits.
- C. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- D. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
 - 1. Where grounding conductors are required in PVC conduit or bare, do not completely encircle conduit or conductor with steel clamp or other steel devices.
 - 2. Where grounding conductor is routed in steel conduit, bond both ends of conduit to grounding conductor with full size conductor.

- B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic welded connectors for outdoor locations, unless a disconnect type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure type connectors.
- D. Non-contact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- F. Compression Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality control testing:

1. After installing grounding system, but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two (2) full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall of potential method according to IEEE 81.
3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
 - a. Equipment Rated 500 kVA and Less: 10 ohms
 - b. Equipment Rated 500 to 1000 kVA: 5 ohms
 - c. Equipment Rated More Than 1000 kVA: 3 ohms
 - d. Substations & Pad Mounted Switching Equipment: 5 ohms
 - e. Manhole Grounds: 10 ohms
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.6 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by work of this section. Re-establish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2, Section 'Landscaping'. Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 26 0526

SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.
 - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- C. Shop drawings indicating details of fabricated products and materials.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70, National Electrical Code.
- B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work, shall include the following:
 - 1. Allied Tube & Conduit.
 - 2. Cooper B-Line, Inc.; a division of Eaton.
 - 3. Thomas & Betts Corporation.
 - 4. Unistrut; an Atkore International brand.
 - 5. Wesanco, Inc.

2.2 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with

treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel springhead type.
 - 3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.4 FABRICATED SUPPORTING DEVICES

- A. General: Shop or field fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:
 - 1. Sheetmetal: Fabricate from galvanized sheetmetal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
 - a. 3-inch and smaller: 20-gauge
 - b. 4-inch to 6-inch: 16-gauge
 - c. over 6-inch: 14-gauge
 - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 - 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in

accordance with NEC requirements.

- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC and the following requirements:
 - 1. Conform to manufacturer's recommendations for selection and installation of supports.
 - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs. safety allowance in the strength of each support.
 - 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 - 6. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with NEC.
 - 7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported, and raceway terminals are not made with chase nipples or threadless box connectors.
 - 8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors.
- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheetmetal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- G. Support EMT and boxes using factory-fabricated components that comply with MFMA-4 standards and that are listed for the application.
- H. Sleeves: Install in concrete slabs and walls and all other fire- rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.
- I. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to

form watertight seal.

- J. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheetmetal screws.
 2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.
- K. Tests: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:
1. Expansion anchors.
 2. Toggle bolts.
 3. Powder-driven threaded studs.
- L. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the Contracting Officer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

3.2 TABLE I: SPACING FOR RACEWAY SUPPORTS

Raceway Size, In.	Location	RMC & IMC (1)	EMT (1)
1/2-1	Any Location	7	7
1 & Larger	Any Location	10	10

NOTES:

- (1) Maximum spacing of supports (feet).
- (2) Maximum spacings for IMC above apply to straight runs only. Otherwise, the maximums for EMT apply.

Abbreviations: EMT Electrical metallic tubing.
IMC Intermediate metallic conduit.
RMC Rigid metallic conduit.

END OF SECTION 26 0529

SECTION 26 0533
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Raceways include the following:
 - 1. Rigid metal conduit.
 - 2. Intermediate metal conduit.
 - 3. Polyvinyl chloride (PVC) externally coated rigid steel conduit.
 - 4. PVC externally coated intermediate metal conduit.
 - 5. Electrical metallic tubing (EMT).
 - 6. Flexible metal conduit.
 - 7. Liquidtight flexible conduit.
 - 8. Rigid nonmetallic conduit.
 - 9. Wireway.
 - 10. Surface raceways.
- C. Boxes, enclosures, and cabinets include the following:
 - 1. Device boxes.
 - 2. Outlet boxes.
 - 3. Pull and junction boxes.
 - 4. Cabinets and hinged cover enclosures.

1.3 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for surface raceway, wireway and fittings, floor boxes, hinged cover enclosures, and cabinets.
- C. Shop drawings for nonstandard boxes, enclosures, and cabinets. Include layout drawings showing components and wiring.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70, National Electrical Code, for components and installation.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
- C. Comply with NECA "Standard of Installation."
- D. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide Products by of one of the following:
 1. AFC Cable Systems, Inc.
 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 3. Anamet Electrical, Inc.
 4. Electri-Flex Company.
 5. O-Z/Gedney; a brand of Emerson Electric Co.
 6. Picoma Industries, a division of Zekelman Industries.
 7. Republic Conduit.
 8. Robroy Industries.
 9. Southwire Company.
 10. Thomas & Betts Corporation.
 11. Western Tube and Conduit Corporation.
 12. Wheatland Tube Company; a division of Zekelman Industries.

2.2 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. Intermediate Metal Conduit: ANSI C80.6.
- C. Electrical Metallic Tubing and Fittings: ANSI C80.3 with set-screw or compression-type fittings.
- D. Flexible Metal Conduit: Aluminum.
- E. Liquidtight Flexible Metal Conduit: Flexible steel conduit with PVC jacket.
- F. Fittings: NEMA FB 1, compatible with conduit/tubing materials.

2.3 NONMETALLIC CONDUIT

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2, Schedule 40 or 80 PVC.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

2.4 WIREWAYS

- A. Material: Sheet metal sized and shaped as indicated.

- B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireway as required for complete system.
- C. Select features where not otherwise indicated, as required to complete wiring system and to comply with NEC.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

2.5 OUTLET AND DEVICE BOXES

- A. Sheet Metal Boxes: NEMA OS 1.
- B. Cast Metal Boxes: NEMA FB 1, type FD, cast ferrous alloy box with gasketed cover.
- C. Nonmetallic Boxes: NEMA OS 2.

2.6 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Boxes: NEMA OS 1.
- B. Cast Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.7 CABINETS AND ENCLOSURES

- A. Hinged Cover Enclosures: NEMA 250, steel enclosure with continuous hinge cover and flush latch. Finish inside and out with manufacturer's standard enamel.
- B. Cabinets: NEMA 250, type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

- A. Outdoors: Use the following wiring methods, 3/4" minimum trade size:
 - 1. Exposed: Rigid or intermediate metal conduit.
 - 2. Concealed: Rigid or intermediate metal conduit.
 - 3. Underground, Single Run: Rigid nonmetallic conduit.

4. Underground, Grouped: Rigid nonmetallic conduit.
5. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquidtight flexible metal conduit.
6. Boxes and Enclosures: NEMA Type 3R or Type 4.

B. Indoors: Use the following wiring methods, 3/4" minimum trade size except as noted below:

1. Connection to Vibrating Equipment and Light Fixtures: (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Flexible metal conduit, except in wet or damp locations use Liquidtight flexible metal conduit, 1/2" trade size minimum.
2. Connection to Light Fixtures: 1/2" trade size minimum, flexible metal conduit, except in wet or damp locations use Liquidtight flexible metal conduit, or solid connection using material conforming to requirements for materials specified in this Paragraph B.
3. Damp or Wet Locations: Rigid steel conduit.
4. Exposed: Electrical metallic tubing.
5. Locations Subject to Physical Damage: Rigid or intermediate steel conduit.
6. Corrosive Locations: Plastic coated rigid steel or rigid non-metallic conduit.
7. Concealed: Electrical metallic tubing.
8. Boxes and Enclosures: NEMA Type 1, except in damp or wet locations use NEMA Type 4, stainless steel.

3.3 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- B. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.
- C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
- D. Install raceways level and square and at proper elevations. Provide adequate headroom.
- E. Complete raceway installation before starting conductor installation.
- F. Support raceway as specified in Division 26, Section 26 0529, Hangers and Supports for Electrical Systems.
- G. Use temporary closures to prevent foreign matter from entering raceway.
- H. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- I. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- J. Use raceway fittings compatible with raceway and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, except as otherwise indicated.
- K. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions, except as otherwise indicated.

- L. Raceways Embedded in Slabs: Install in middle third of the slab thickness where practical and leave at least 1-inch concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in the concrete.
 - 3. Run conduit larger than 1-inch trade size (size 27) parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.
- M. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members and follow the surface contours as much as practical.
 - 1. Run parallel or banked raceways together, on common supports where practical.
 - 2. Make bends in parallel or banked runs from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.
- N. Join raceways with fittings designed and approved for the purpose and make joints tight.
 - 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - 2. Use insulating bushings to protect conductors.
- O. Tighten set screws of threadless fittings with suitable tool.
- P. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.
- Q. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- R. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.
- S. Install raceway sealing fittings according to the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
 - 1. Where conduits enter or leave hazardous locations.
 - 2. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
 - 3. Where otherwise required by the NEC.
- T. Stub-Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may

be used 6 inches above the floor. Install insulated grounding bushings on each conduit and bond to ground system. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs flush with floor.

- U. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use Liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.
- V. Do not install aluminum conduit embedded in or in contact with concrete.
- W. Underground 90-degree elbows 2-inch trade size or larger, use plastic coated or tape wrapped intermediate metal or rigid steel conduit. Comply with NEC for grounding.
- X. Install hinged cover enclosures and cabinets plumb. Support at each corner.
- Y. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.
- Z. On all service, feeder, and branch circuit conduits, 2-inches and large, install grounding-type insulated bushings on each conduit entering all boxes, enclosures, and equipment. Bond conduit grounding bushing to a grounding bus in box, enclosure, or equipment with conductor sized per NEC 250-95. Do not use grounding conductor to bond bushing to grounding bus.
- AA. All exposed conduit, fittings, boxes, hangers, clips, supports, etc., in finished areas to be painted per the Architect's/Engineer's instructions.

3.4 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touch-up coating recommended by the manufacturer.

3.5 CLEANING

- A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 26 0533

SECTION 26 0549
INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. See Division 23, Section 23 0549, HVAC & Electrical Installation Coordination
- B. See Mechanical Drawings for control requirements and for items requiring 120V power.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION 26 0549

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes identification of electrical materials, equipment, and installations.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.
- C. Schedule of identification nomenclature to be used for identification signs and labels.
- D. Samples for each color, lettering style, and other graphic representation required for identification materials, samples of labels and signs.
- E. Details of EIA/TIA 606 compliance for labeling.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with EIA/TIA 606 for telephone, data, and fiber optic systems.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.
- B. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Labelmark Co.; Labelmaster Subsidiary
 - 2. Brady USA, Inc.; Industrial Products Div.

3. Calpico, Inc.
4. Carlton Industries, Inc.
5. Champion American, Inc.
6. Cole-Flex Corp.
7. D&G Sign and Label
8. EMED Co., Inc.
9. George-Ingraham Corp. (The)
10. Grimco, Inc.
11. Ideal Industries, Inc.
12. Kraftbilt
13. LEM Products, Inc.
14. Markal Corp.
15. National Band & Tag Co.
16. Panduit Corp.
17. Radar Engineers
18. Ready Made Sign Co., Cornerstone Direct Corp. Div.
19. Seton Name Plate Co.
20. Standard Signs, Inc.

2.2 RACEWAY AND CABLE LABELS

- A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.
 1. Color: Black legend on orange field.
 2. Legend: Indicates voltage and service.
- C. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl. Legend is over-laminated with a clear, weather- and chemical-resistant coating.
- D. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic bands sized to suit the diameter of the line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.
- E. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- F. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- G. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- H. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.
- I. Aluminum-Faced Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both

sides with embossable aluminum sheet, 0.002 inch thick, laminated with moisture-resistant acrylic adhesive, and punched for the fastener. Preprinted legends suit each application.

- J. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 by 2 inches by 0.05 inch.

2.3 ENGRAVED NAMEPLATES AND SIGNS

- A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Engraving stock, melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 sq. in., 1/8 inch thick for larger sizes.
 - 1. Engraved Legend:
 - a. Normal Power – White letters on black face, unless noted otherwise on drawings.
 - b. Emergency Power – White letters on red face, unless noted otherwise on drawings.
 - c. UPS Power – White letters on blue face, unless noted otherwise on drawings.
 - 2. Punched for mechanical fasteners.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for the application. 1/4-inch grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396-inch, galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.
- E. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties with the following features:
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 50 lb minimum.
 - 3. Temperature Range: Minus 40 to 185 deg F (Minus 4 to 85 deg C).
 - 4. Color: As indicated where used for color coding.
- B. Paint: Alkyd-urethane enamel over primer as recommended by enamel manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install identification devices according to manufacturer's written instructions.

- B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.
- D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
- F. Install painted identification as follows:
 - 1. Clean surfaces of dust, loose material, and oily films before painting.
 - 2. Prime Surfaces: For galvanized metal, use single-component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy-duty, acrylic-resin block filler. For concrete surfaces, use clear, alkali-resistant, alkyd binder-type sealer.
 - 3. Apply one intermediate and one finish coat of silicone alkyd enamel.
 - 4. Apply primer and finish materials according to manufacturer's instructions.
- G. Install Circuit Identification Labels on Boxes: Label externally as follows:
 - 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
 - 2. Concealed Boxes: Plasticized card-stock tags.
 - 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
- H. Color-Code Conductors: Secondary service, feeder, and branch circuit conductors throughout the secondary electrical system.
 - 1. 208/120-V System: As follows:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green.
 - 2. 480/277-V System: As follows:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Grey.
 - e. Ground: Green.
 - 3. Factory-apply color the entire length of the conductors, except the following field-applied, color-coding methods may be used in lieu of factory-coded wire for phase conductor's sizes larger than No. 10 AWG and grounded conductors and grounding conductors larger than No. 6 AWG.

- a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
- I. Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.
 1. Legend: 1/4-inch steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 2. Fasten tags with nylon cable ties; fasten bands using integral ears.
- J. Apply identification to conductors as follows:
 1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
 3. Multiple Control and Communications Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking tape.
- K. Apply warning, caution, and instruction signs and stencils as follows:
 1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
 2. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- L. Install identification as follows:
 1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide a single line of text with 1/2-inch-high lettering on 1-1/2-inch-high label; where 2 lines of text are required, use lettering 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment.

Example: Panel 1H1 120/208V, 3-PH, 4-wire fed from panel MDR-CCT#4.

- a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Motor starters.
 - d. Switches and receptacles.
2. Circuits: Apply identification labels of engraved plastic laminate on each switch and receptacle indicating panelboard and circuit number supplying receptacle.
3. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

END OF SECTION 26 0553

SECTION 26 0573
POWER SYSTEM ANALYSIS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: This Section covers the furnishing of an electrical short circuit and arc flash study for the building electrical system installed under this contract, including as much of existing system as required for a complete study.

1.2 SUBMITTALS

- A. Industry Standards: Provide, for each section of the study, an identification and description of the industry testing standards on which the study is based.

1.3 STUDY REQUIREMENTS

- A. Perform study using procedures outlined in IEEE 241 and IEEE 242.
- B. Power Company: The study shall include the utility power company's system and relay characteristics.
- C. General Content: Provide calculations, impedance diagrams, conclusions and recommendations as part of the general content of the study.
- D. Ground Fault Study: Include a ground fault study for each low voltage switchgear line-up, switchboard, motor control center, distribution panelboard, branch circuit panelboards and other significant locations throughout the system.
- E. Short Circuit: Provide short circuit tabulations which include the system impedances, X/R ratio, asymmetry factor, kVA, symmetrical and asymmetrical fault currents.
- F. Preparer: The system studies shall be prepared and signed by a registered engineer experienced in providing such studies.
- G. Contract Drawings: The drawings and specifications indicate the general requirements for the low voltage equipment. Determine additional specific characteristics of equipment furnished in accordance with the results of the short circuit and protective device coordination study.
1. Submit any equipment design discrepancies and the proposed corrective modifications, if required, with the short circuit and protective device coordination study. Identify any variations clearly on the subsequent shop drawings.
 2. Provide the necessary field settings, adjustments, and minor modifications for conformance with the approved short circuit study, without additional expense.

1.4 ARC-FLASH HAZARD ANALYSIS REQUIREMENTS

- A. Perform preliminary and final arc-flash analyses for new installations using procedures outlined in NFPA 70E and IEEE 1584.

- B. Perform preliminary arc-flash calculations in the selection of equipment to reduce or eliminate the risk of arc-flash hazards.
- C. Prepare arc-flash studies in accordance with the scope and deliverable requirements in IEEE 1584.1.
- D. An arc-flash hazard analysis is not required for equipment that operates at 240V and below unless it involves at least one 125 kVA or larger low-impedance transformer in its immediate power supply.
- E. Extend arc-flash hazard calculations to points in the distribution system where the calculated incident energy at the assumed working distance is less than 1.2 calories per square centimeter.
- F. Where possible, the electrical system shall be designed to limit arc-flash incident energy to a level that does not exceed Category 2 personal protective equipment (PPE) per NFPA 70E, latest edition.
- G. Specify overcurrent protective device settings to achieve the required arc-flash results.
- H. Reconcile arc-flash protective device setting recommendations with time-current coordination study.
- I. Conduit final arc-flash analysis as part of the fault-current and device coordination study.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 FIELD DATA

- A. Collect all required data from utility, existing conditions, existing transformers, fuses and circuit breakers.

3.2 SUBMISSION

- A. Submit final study including all as-built conditions prior to acceptance of project.
- B. Renovation Projects: Install arc-flash warning labels on existing equipment where lock-out/tag-out will be required for the renovation work.
- C. Prepare arc-flash signage for all of the following:
 - 1. Switchboards
 - 2. Panelboards
 - 3. Variable frequency drives
 - 4. Machine control panels
 - 5. Fused and non-fused disconnect switches.
 - 6. Motor terminal boxes
 - 7. Other Equipment required by NEC 110.16

- D. Arc-flash labels shall be orange warning labels for incident energy levels equal to or less than 40 calories per square centimeter and red danger label for incident energy levels above 40 calories per square centimeter. Label must be readable in both indoor and outdoor environments for at least 3 years and contain the following minimum information:
1. Arc hazard boundary (inches)
 2. Working distance (inches)
 3. Arc flash incident energy at the working distance (calories per square centimeter)
 4. Available (maximum) fault current at the equipment/bus (kA)
 5. PPE category (1, 2, 3, or 4) and description including the glove rating.
 6. Voltage rating of the equipment
 7. Limited approach distance (inches)
 8. Restricted approach distance (inches)
 9. Prohibited approach distance (inches)
 10. Equipment/bus name
 11. Date prepared
 12. Supplier name and address

END OF SECTION 26 0573

SECTION 26 2413
SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes service and distribution switchboards rated 600 V and less.

1.3 SUBMITTALS

- A. Product Data: For each product and component specified.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- C. Reports of Field Tests and Observations: Certified by testing agency.
- D. Manufacturer field service report.
- E. Certificates for field testing agency, signed by Contractor, certifying that agency complies with requirements specified in "Quality Assurance" Article below.
- F. Maintenance Data: For switchboards to include in the maintenance manuals specified in Division 1. Include detailed manufacturer's written instructions on adjusting overcurrent protective devices.
 - 1. Routine maintenance requirements.
 - 2. Time current curves, including selectable range, for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section Quality Control, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full-member company of the InterNational Electrical Testing Association.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.
- B. Listing and Labeling: Provide switchboard assemblies specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
- C. Comply with NFPA 70.
- D. Comply with NEMA PB 2.

- E. Comply with UL 891.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path.
- B. Store so condensation will not occur on or in switchboards. Provide temporary heaters as required to avoid condensation.
- C. Handle switchboards according to NEMA PB 2.1. Use only factory-installed lifting provisions.

1.6 PROJECT CONDITIONS

- A. Verify dimensions by field measurements.
- B. Determine suitable path for moving switchboard into place considering Project conditions.
- C. Verify clearance requirements. Locate switchboard to meet installation tolerances.
- D. Revise locations and elevations from those indicated as required to suit Project conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Match existing switchboard for new breakers.

2.2 OVERCURRENT PROTECTIVE DEVICES

- A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.
 - 1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
 - a. 10,000A RMS symmetrical minimum for 208Y/120V and 120/240V applications.
 - b. 14,000A RMS symmetrical minimum for 480V and 480Y/277V applications.
 - 2. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.
 - 3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
 - 4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.
 - 5. Circuit Breakers, 400A and larger must be 100% continuous current rated and identified on the one-line diagram.
 - 6. Use common-trip type 2- and 3-pole breakers so that an overload or fault on one pole will trip all poles simultaneously; hand ties are not acceptable.
 - 7. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
 - 8. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
 - 9. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

2.3 IDENTIFICATION

- A. Nameplates and label products are specified in Division 26, Section 26 0553, Identification for Electrical Systems.
 - 1. Compartment Nameplates: Engraved laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws.
- B. Provide circuit directory per NEC 408.4 and as follows:
 - 1. Neatly typed.
 - 2. Text no smaller than 1/8" high
 - 3. Clear heat-resistant plastic cover
 - 4. Metal frame on inside door of the equipment
 - 5. No adhesive-mounted directory pockets
 - 6. Must contain all information contained in the panel schedule except load calculations.
- C. Working space markers: provide working space markers per Division 26, Section 26 0553, Identification for Electrical Systems.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive switchboard for compliance with installation tolerances and other conditions affecting performance of switchboards.
 - 1. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install compartment nameplates.
- B. Install circuit directory.

3.3 CONNECTIONS

- A. Connect switchboards and components to wiring systems and to ground as indicated and instructed by manufacturer.
 - 1. Tighten electrical connectors and terminals, including screws and bolts, according to manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Standards: Comply with applicable standards of the InterNational Electrical Testing Association (NETA), including standard ATS.
- B. Prepare for acceptance tests as follows:
 - 1. Make insulation-resistance tests of each switchboard bus, component, and connecting

- supply, feeder, and control circuits. Insulation resistance less than 100 megohms is not acceptable.
 - 2. Make continuity tests of each circuit.
 - C. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise pretesting and adjustment of switchboard components for a total of not less than **[five (5)]** working days.
 - D. Testing Agency: Owner will engage a qualified independent testing agency to perform specified acceptance testing.
 - E. Acceptance Testing: After installing switchboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Sections 7.1, 7.5 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.
 - F. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final Acceptance, perform an infrared scan of each switchboard. Remove fronts to make joints and connections accessible to a portable scanner.
 - 1. Follow-up Infrared Scanning: Perform 1 additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - 2. Instrument: Use an approved infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.
 - 3. Record of Infrared Scanning: Prepare a certified report identifying switchboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 3.5 ADJUSTING
- A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- 3.6 CLEANING
- A. Upon completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION 26 2413

SECTION 26 2726
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes various types of receptacles, connectors, switches, and finish plates.

1.3 SUBMITTALS

- A. Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for each product specified, including all information required to show compliance with all requirements.
- C. Operation and maintenance data for materials and products specified in this Section to include in the "Operating and Maintenance Manual" specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70, National Electrical Code for devices and installation.
- B. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper Industries.
 - b. General Electric Co.
 - c. Hubbell Inc.
 - d. Leviton Mfg. Co., Inc.
 - e. Pass & Seymour/Legrand

2.2 WIRING DEVICES

- A. Comply with NEMA Standard WD 1, "General Purpose Wiring Devices."
- B. Enclosures: NEMA 1 equivalent, except as otherwise indicated.

- C. Color: White except as otherwise indicated or required by Code.
- D. Receptacles, Straight-Blade, and Locking Type: Except as otherwise indicated, comply with Federal Specification W-C-596 and heavy-duty grade of UL Standard 498, "Electrical Attachment Plugs and Receptacles." Provide NRTL labeling of devices to verify these compliances. 20A unless noted otherwise.
- E. Receptacles, Straight-Blade, Special Features: Comply with the basic requirements specified above for straight-blade receptacles of the class and type indicted, and with the following additional requirements:
 - 1. Ground-Fault Circuit Interrupter (GFCI) Receptacles: UL Standard 943, "Ground Fault Circuit Interrupters," feed-through type, with integral NEMA 5-20R duplex receptacle arranged to protect connected downstream receptacles on the same circuit. Design units for installation in a 2-3/4-inch-deep outlet box without an adapter.
- F. Weatherproof Receptacles: Duplex receptacles, comply with basic requirements above. Cast metal box, cover plate, and cover to provide weatherproof capability with plugs and cords installed.
- G. Wall Plates: Single and combination types that mate and match with corresponding wiring devices. Features include the following:
 - 1. Color: Matches wiring device except as otherwise indicated.
 - 2. Plate-Securing Screws: Metal with heads colored to match plate finish.
 - 3. Material for Unfinished Spaces: Galvanized steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies' plumb and secure.
- B. Install wall plates when painting is complete.
- C. Arrangement of Devices: Except as otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- D. Protect devices and assemblies during painting.
- E. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit the indicated arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 26, Section 26 0553, Identification for Electrical Systems.
 - 1. Switches: Where 3 or more switches are ganged, and elsewhere where indicated, identify each switch with approved legend engraved on wall plate.
 - 2. Receptacles: Identify the panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

3.3 GROUNDING

- A. Equipment Ground: Connect to device and to box.

3.4 FIELD QUALITY CONTROL

- A. Testing: Test wiring devices for proper polarity and ground continuity. Operate each operable device at least 6 times.
- B. Test ground-fault circuit interrupter operation with both local and remote fault simulations according to manufacturer recommendations.
- C. Replace damaged or defective components.

3.5 CLEANING

- A. General: Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices. Replace wall plates or devices marked with pencil, pen, or other non-standard marking system. Thoroughly clean all device plates, remove fingerprints, smudges, and dirt.

END OF SECTION 26 2726

5.3.7.2 SPECIFICATIONS

The internal perimeter ground (earth) bus conductors **shall** be a 35 mm² csa (#2 AWG) or coarser copper conductor, free of splices. When the conductors are insulated, they **shall** be listed for the space in which they are intended to be placed and the jacket **shall** be green or properly marked with a distinctive green color (ANSI-J-STD-607-A-2002). If a splice in the bus conductor is unavoidable, it **shall** be exothermically welded or spliced using a listed irreversible connection. It is desirable that this conductor be stranded for better flexibility and ease of installation and maintenance. However, this conductor may be a solid conductor, copper bus bar, or copper strap of equal or larger surface area.

5.3.8 EQUIPMENT GROUNDING (EARTHING) CONDUCTORS

An equipment grounding (earthing) conductor bonds equipment chassis or frames, and metallic ancillary support apparatus to the internal grounding system. An equipment grounding conductor from each piece of electronic equipment **shall** be bonded to the MGB, SSGB, RGB, ground bus conductor or ground bus extension using suitable methods described within this chapter. An equipment grounding conductor from each piece of ancillary support apparatus **shall** be bonded to the MGB, SSGB or internal perimeter ground bus (IPGB) conductor using suitable methods described within this chapter.

NOTE: Braided conductors **shall not** be used at any location.

5.3.8.1 LOCATION

The equipment grounding (earthing) conductor for electronic equipment **shall** be suitably supported. One end of the conductor **shall** be bonded to the equipment or support apparatus using methods described within this chapter. The other end of the conductor **shall** be bonded to the ground bus conductor, RGB, SSGB, or MGB using suitable methods described within this chapter. See Figure 5-17 on page 5-24.

5.3.8.2 SPECIFICATIONS

The equipment grounding (earthing) conductor **shall** be a 16 mm² csa (#6 AWG) or larger, green-jacketed, solid or stranded copper conductor. A stranded conductor may be more desirable due to the ease of installation and maintainability. If the equipment grounding conductor length must exceed 4 m (13 ft.) before it terminates to a ground bus conductor, RGB, SSGB, or MGB, the conductor **shall** be sized according to Table 5-5.

TABLE 5-5 SIZING OF GROUND BUS CONDUCTORS

Conductor length in linear m (ft)	Conductor size in mm ² csa (AWG)	International Conductor size (mm ² csa)
Less than 4 (13)	13.30 (6)	16
4 – 6 (14 – 20)	21.15 (4)	25
6 – 8 (21 – 26)	26.67 (3)	30
8 – 10 (27 – 33)	33.62 (2)	35

5.4 CONNECTION METHODS FOR INTERNAL GROUNDING (EARTHING) SYSTEM

All components of the internal grounding (earthing) system and all equipment and ancillary support apparatus including, but not limited to, items listed in Table 5-6 on page 5-40 **shall** be effectively bonded together by using the following requirements and connection methods described within this chapter:

- General bonding requirements
- Bonding to equipment and ancillary support apparatus
- Bonding to the MGB
- Bonding to SSGB
- Bonding to RGB
- Bonding to ground bus conductor
- Bonding to communication bonding backbone conductors and grounding equalizer conductors

5.4.1 GENERAL BONDING REQUIREMENTS

The following requirements **shall** apply when attaching conductors to equipment, ancillary support apparatus, ground (earth) bus bars, and when attaching one conductor to another.

- Only connection devices that require the complete removal of the conductor jacket or insulation and result in a connection to the complete conductor surface area **shall** be suitable for use.
- All mechanical and compression-type connection devices **shall** be UL 486A listed and of the proper size for the application. These connection devices **shall** be tin-plated when connected with steel, galvanized steel or aluminum surfaces.
- All clamps and compression-type connection devices **shall** be UL 486A listed and **shall** maintain a minimum 88% conductivity rating.
- Compression systems **shall** include crimped die index and company logo for purposes of inspection.
- Listed two-hole, long barrel, compression lugs are preferred over single-hole lugs and **shall** be required where two-hole lugs are referenced within this chapter.
- No more than one clamp, fitting or lug may be attached by the same bolt or bolts. An exception to this is when a jumper from a terminal strip or other internal connection point of the same equipment must be bonded to the equipment grounding conductor.
- No more than one conductor **shall** be connected by a single clamp, fitting or lug unless the clamp, fitting, or lug is listed for multiple conductors.
- Solid conductors **shall** be attached to lugs and to other conductors by irreversible high compression crimping process. Only listed irreversible compression type lugs and connection devices **shall** be used.
- Connections between dissimilar metals **shall not** be made unless the conductors are separated by a suitable material that is a part of the attachment device. Only attachment devices listed and approved for use with the specific dissimilar metals may be used for this purpose.

- An appropriate type of listed, conductive anti-oxidant **shall** be applied on all connections of dissimilar metals. Copper enhanced anti-oxidant compound should be used between copper, brass, bronze and tin-plated bonding surfaces. Zinc enhanced anti-oxidant compound should be used between tin-plated connection devices and steel, galvanized steel, zinc-chromate steel, aluminum, and tin-plated copper bus bar bonding surfaces.
- Where threaded or tapped holes are provided for attachment purposes, a star or split type lock washer **shall** be installed under the head of the screw or bolt and/ or between the nut and the ground bus bar. See Figure 5-19 on page 5-32 for the correct location of the star or split washer in these instances.
- Self-tapping or sheet metal type screws **shall not** be used for attaching ground or grounding conductors to any surface. (See NFPA 70-2005, Article 250.8 for additional information.)
- Paint, enamel, lacquer, or other nonconductive coatings **shall** be removed from threads and surface areas where connections are made (NFPA 70-2005, Article 250.12). Use of a star washer **shall not** alleviate the requirement to remove nonconductive coatings from attachment surfaces. Star or split type washers **shall not** be installed between the conductive surfaces. Proper placement of lockwasher is shown in Figure 5-19.

NOTE: Do not install a washer of any kind between the ground lug and the bonding surface.

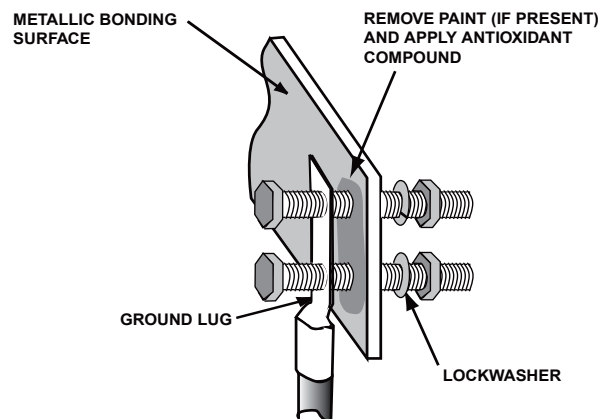


FIGURE 5-19 PROPER LOCATION OF WASHER WHEN CONNECTING GROUND LUG

- All two-hole lugs **shall** have bolts in both holes with lock washers placed on the nut side of the bonding surface.
- All securing hardware for mechanically bolted clamps and lugs **shall** be stainless steel or approved for the application.

The following methods of connection are **unacceptable** and **shall not** be used:

- Insulation piercing connectors.
- Self-tapping or sheet metal type screws **shall not** be used to provide continuous and permanent electrical bonds (NFPA 70-2005, Article 250.8 and FAA-STD-019d-2002).
- Tinnerman or similar type clips (FAA-STD-019d-2002).
- Aluminum connection devices.

- Star or split washers **shall not** be installed between conductive surfaces. These washers may be used only under the head and/or nut of the bolt as shown in Figure 5-19.
- The series or daisy chain method of connecting a conductor from one piece of equipment to another and then to the ground bus conductor **shall not** be permitted (FAA-STD-019d-2002). The series or daisy chain method refers to any method of connection whereby the conductors are connected from one chassis, equipment frame or rack connection point to a second chassis, equipment frame or rack connection point and on to a third connection point, creating a series arrangement whereby the removal of the second connection point interrupts the ground path from the first chassis, equipment frame or rack. See Figure 5-20 on page 5-34.
- When attaching two conductors together, or attaching a conductor to a lug, connections **shall not** depend solely on solder (NFPA 70-2005, Articles 250.8 and 250.70) although properly crimped connections may be soldered.
- Crimp connections **shall not** be used on solid conductors unless they are listed and approved for the application.
- Mechanical lugs and clamps (such as set screw lug or clamp) **shall not** be used on solid conductor.
- Conductors **shall not** extend through or beyond the clamp, fitting or lug unless the device is designed and listed to permit this conductor extension.
- Braided conductors **shall not** be used as a ground bus or equipment grounding conductor at any location (FAA-STD-019d-2002).

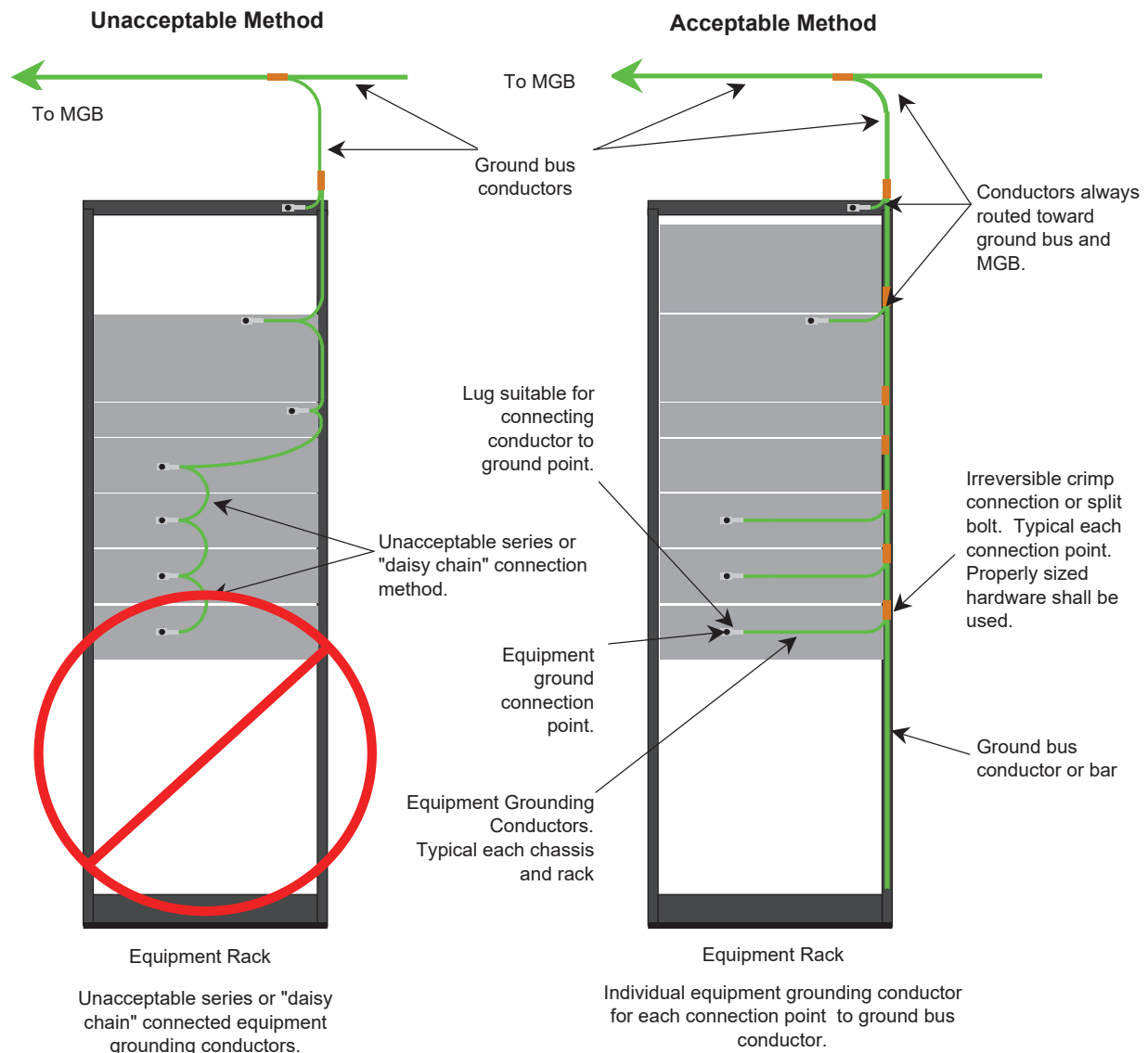


FIGURE 5-20 DAISY CHAIN GROUNDING NOT ALLOWED

5.4.2

BONDING TO EQUIPMENT AND ANCILLARY SUPPORT APPARATUS

All applicable general and below bonding requirements **shall** apply when attaching equipment grounding (earthing) conductors to equipment and ancillary support apparatus:

- Each electronic equipment chassis **shall** have a separate and independent equipment grounding conductor.
- Paint, enamel, lacquer and other electrically non-conductive coatings **shall** be completely removed from threads and bonding surface areas to ensure good electrical continuity (NFPA 70-2005, Article 250.12).

NOTE: Use of a star washer does not alleviate the requirement to remove non-conductive coatings from attachment surfaces because the star washer does not provide enough contact surface area.

- Connections to steel and galvanized steel pipes, conduit or other round member items **shall** be made using a UL 486A listed, bolted clamp with stainless steel securing hardware or other suitable listed means. In high humidity areas, the clamps **shall** be stainless steel or tin-plated UL 486A listed to prevent galvanic corrosion.
- Connections to vibrating or moveable items **shall** be made by using an exothermic weld or a compression-type two-hole lug.
- Connections to structural building steel **shall** be made by using an exothermic weld, listed irreversible high compression-type connection, or listed tin-plated flange-type bonding connector that is equipped with two securing bolts. Figure 5-21 shows examples of flange-type bonding connectors.

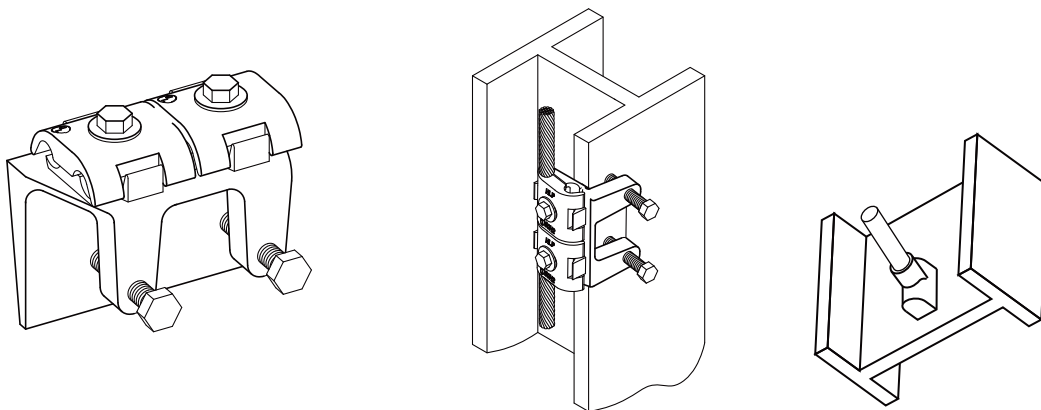


FIGURE 5-21 ACCEPTABLE BUILDING STEEL BONDING CONNECTIONS

- Connections to raised flooring support system **shall** be made using a tin-plated listed compression lug, listed pedestal clamp, or exothermic welding. Where practical the lug should be effectively bonded to the pedestal's upper support plate or to cross connecting stringer. Figure 5-22 shows some examples of acceptable pedestal bonding configurations.

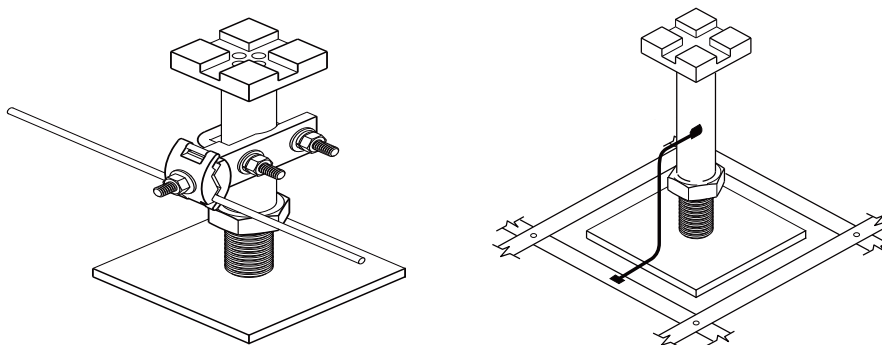


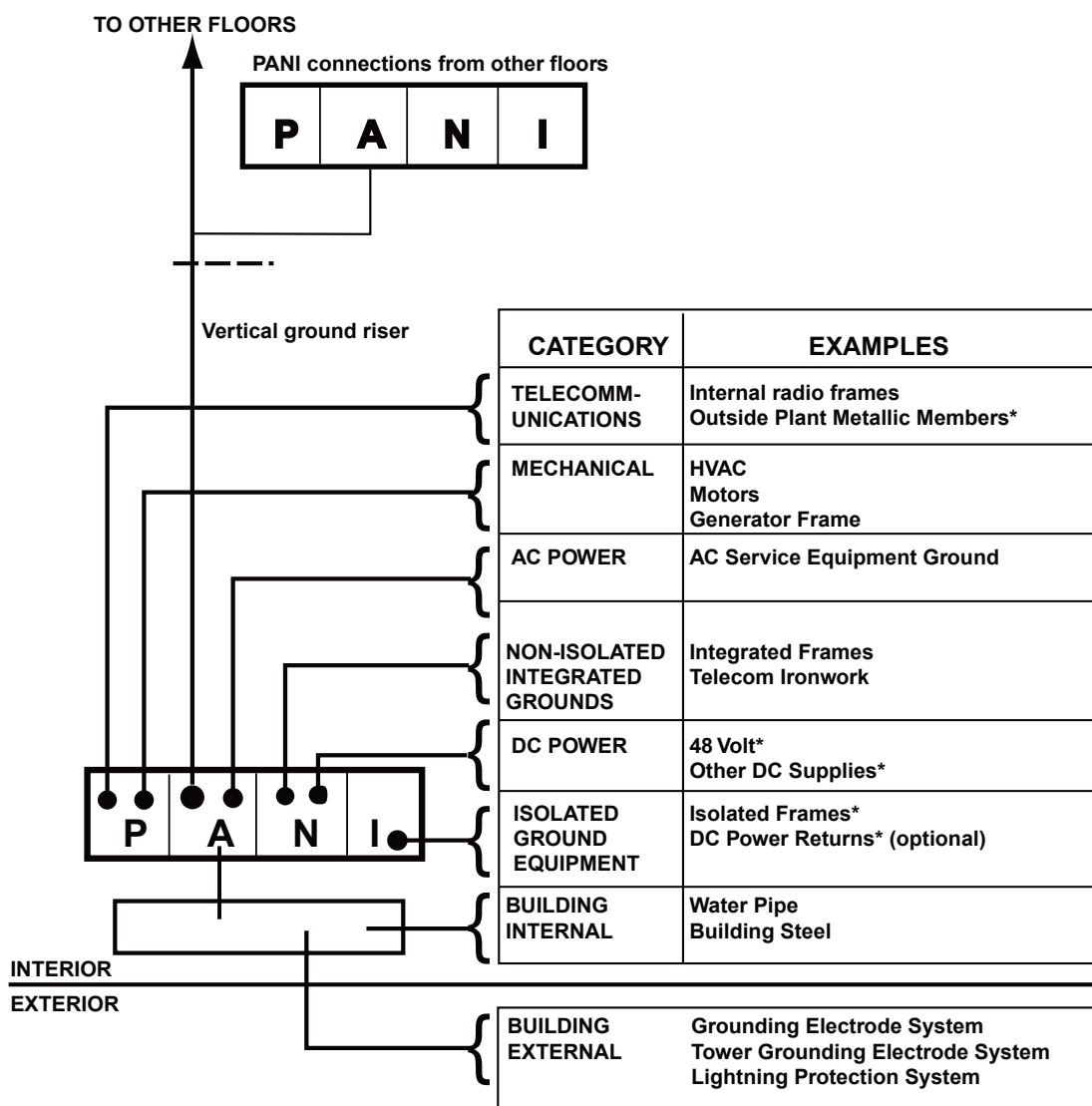
FIGURE 5-22 ACCEPTABLE RAISED FLOORING BONDING CONNECTIONS

5.4.3 BONDING TO THE MGB, SSGb AND RGB

All applicable general bonding requirements and the bonding requirements listed below **shall** apply when attaching grounding (earthing) conductors, grounding electrode conductors, ground bus conductors and equipment grounding conductors to the MGB, SSGb or RGB:

- The MGB grounding conductor(s) **shall** be installed using the shortest and straightest downward-flowing path toward the earth and the grounding electrode system. For examples of grounding conductor routing requirements see Figure 5-8 on page 5-12 and Figure 5-9 on page 5-14.
- All ground bus conductors and equipment grounding conductors bonded directly to the MGB, SSGb or RGB **shall** have a direct path back toward the grounding electrode system.
- Connection of a grounding conductor, grounding electrode conductor, communication bonding backbone conductor and ground bus conductor to the MGB or SSGb **shall** utilize exothermic welding, listed irreversible compression-type connection or listed compression two-hole lug and securing hardware of the proper size for the application unless otherwise specified within this chapter (ANSI-J-STD-607-A-2002).
- Connection of a grounding conductor, grounding electrode conductor and ground bus conductor to the RGB **shall** utilize exothermic welding, listed irreversible compression-type connection, or listed compression lug and securing hardware of the proper size for the application. Listed compression two-hole lugs are preferred.
- Connection of an equipment grounding conductor to the MGB, SSGb or RGB **shall** utilize exothermic welding, listed irreversible compression-type connection, listed compression lug, or listed pressure lug and securing hardware of the proper size for the application. Listed compression two-hole lugs are preferred (ANSI-J-STD-607-A-2002).
- Grounding materials should be of copper or copper alloy. Where other materials are used in conjunction with copper or copper alloy, care **shall** be exercised in providing proper bimetallic couplings to reduce the possibility of galvanic corrosion (ANSI T1.334-2002; ANSI T1.313-2003).
- It is desirable for the MGB, SSGb, and RGB to be electrotin-plated for reduced contact resistance. If not electrotin-plated, the bus bar bonding surface **shall** be cleaned prior to fastening the conductor's connection device. An appropriate type of listed conductive anti-oxidant compound should be applied to the contact area to control corrosion and reduce contact resistance of mechanical and compression-type connections.

Some customers such as cellular operators may require that conductors be bonded to the MGB in a specific sequence or order determined by the conductor's origin or the type of equipment being bonded to the MGB. One of these methods, known as PANI, allocates specific areas of the MGB for bonding surge energy **P**roducers, **A**bsorbers, **N**on-isolated equipment, and **I**solated equipment. An example of this type of configuration is shown in Figure 5-23 and Figure 5-24. This method is not required for compliance with this installation standard and is provided for reference only. See ANSI T1.313-2003 for additional information on this method of bonding to the MGB.

**NOTE:**

Items marked with an asterisk (*) may have ground bars associated with them.

FIGURE 5-23 PANI GROUNDING SYSTEM SEQUENCE

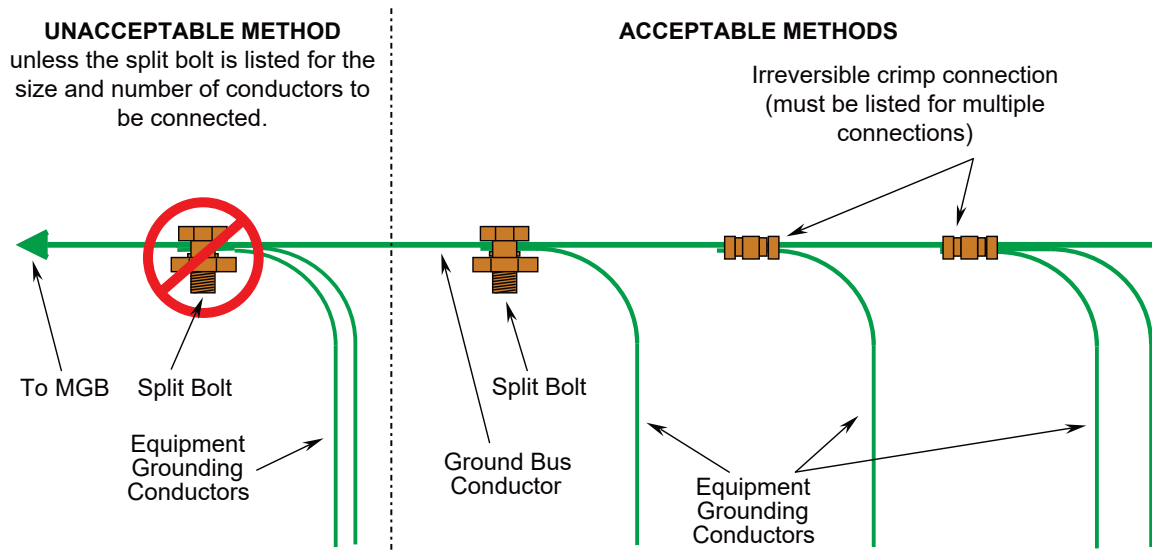
P	A	N	I
Surge Producers	Surge Absorbers	Non IGZ	Isolated Ground Zones (IGZ)
• RF SPD • AC Equip. • Tel. SPD • Cable Shields • ESD	• Building Steel • AC NG Bond • Water Line • Metallic Piping • Concrete Encased Electrode • Ground Rings	• +48VDC GND. • -24VDC GND. • Cable Tray Sys. • Equip. Frame • Battery Racks • Ancillary Equip.	• Logic Ground. • IG Zones

FIGURE 5-24 PANI BUS BAR CONFIGURATION

5.4.4 BONDING TO GROUND (EARTH) BUS CONDUCTORS

All applicable general bonding requirements **shall** apply when attaching ground (earth) bus extension conductors and equipment grounding conductors to a ground bus conductor. The following requirements also apply:

- All ground bus conductors should be installed without splices. Where splices are necessary, the number of splices should be kept to a minimum and they **shall** be accessible and only located in telecommunication spaces. The joined segments **shall** be connected using exothermic welding or listed irreversible compression-type connectors. All bonding joints **shall** be adequately supported and protected from damage (ANSI-J-STD-607-A-2002).
- Ground bus extension conductors **shall** always be routed toward the MGB or SSGB at the point of connection to the ground bus conductor. Ground bus extension conductors **shall** be connected to the ground bus conductor using exothermic welding or listed irreversible compression-type connectors. Connection points **shall** be taped with a suitable green tape or otherwise isolated from contact with the cable tray or other metallic surfaces.
- Equipment grounding conductors **shall** always be routed toward the MGB or SSGB at the point of connection to the ground bus conductor. Equipment grounding conductors **shall** be connected to the ground bus conductor using exothermic welding, listed compression-type connections, or listed split bolt connections. Connection points **shall** be taped with a suitable green tape or otherwise isolated from contact with the cable tray or other metallic surfaces.
- Equipment grounding conductors **shall** be connected so that the removal of a connection will not break the ground path to any other piece of equipment or ancillary support device that may have electrical power applied.
- Multiple connections **shall not** be made to one attachment point on the ground bus conductor unless this connection is made using exothermic welding, listed irreversible compression-type connector or listed split bolt. In all cases the connection means **shall** be listed for the size and number of conductors to be connected.



NOTE: Route all conductors toward the MGB.

FIGURE 5-25 BONDING TO GROUND BUS CONDUCTOR

5.4.5 BONDING TO COMMUNICATION BONDING BACKBONE CONDUCTORS AND GROUNDING (EARTHING) EQUALIZER CONDUCTORS

All applicable general bonding requirements and the requirements below **shall** apply when attaching SSGB grounding (earthing) conductors to a communication bonding backbone conductor or a grounding equalizer conductor.

NOTE: Only SSGBs should be bonded back to a communication bonding backbone conductor or a grounding equalizer conductor. All equipment and ancillary apparatus grounding conductors should be bonded back to the SSGB as described within this chapter.

- All communication bonding backbone conductors should be installed without splices. Where splices are necessary, the number of splices should be kept to a minimum and they **shall** be accessible and only located in telecommunication spaces. The joined segments **shall** be connected using exothermic welding or listed irreversible compression-type connectors. All bonding joints **shall** be adequately supported and protected from damage (ANSI-J-STD-607-A-2002).
- The bonding conductor between the SSGB and the communication bonding backbone or grounding equalizer conductor **shall** be of the same specifications as the communication bonding backbone conductor.
- The bonding conductor between the SSGB and the communication bonding backbone or grounding equalizer conductor **shall** be continuous and routed in the shortest possible straight line path back towards the MGB. If a bend is required in the SSGB bonding conductor, minimum bending radius and angle **shall** be adhered to.

- The SSGB bonding conductor **shall** be connected to the communication bonding backbone conductor or to the grounding equalizer conductor with an exothermic welding or listed irreversible compression-type connection (ANSI-J-STD-607-A-2002)
- When a grounding equalizer conductor is installed as described within this chapter, it **shall** be bonded back to the SSGBs and not to the communication bonding backbone conductors.
- The grounding equalizer conductor **shall** be connected to the SSGBs with exothermic welding, listed compression-type two-hole lugs, or listed irreversible compression type connections.
- Only the far end of a communication bonding backbone conductor may be connected directly to the SSGB. If the communication bonding conductor is connected directly to the SSGB, it **shall** be connected with exothermic welding or irreversible compression type connection. See Figure 5-4 on page 5-7 for an example of this type of grounding system configuration.

5.5 BONDING EQUIPMENT TO INTERNAL GROUNDING (EARTHING) SYSTEM

All equipment and ancillary support apparatus **shall** be bonded to the MGB, SSGB, RGB, ground (earth) bus conductor or internal perimeter ground bus (IPGB) conductor with an equipment grounding conductor as described within this chapter.

TABLE 5-6 BONDING TO THE INTERNAL GROUNDING SYSTEM FROM ITEM TOWARD EARTH

From	To					Minimum Conductor Size Unless Otherwise Specified	
Item	MGB	SSGB	RGB	Ground Bus Conductor	IPGB	35 mm ² csa (#2 AWG)	16 mm ² csa (#6 AWG)
SSGB	✓	✓		✓		✓	
RGB	✓	✓	✓	✓		✓	
Equipment ground bus extension	✓	✓	✓	✓		✓	
Equipment cabinet	✓	✓	✓	✓			✓
Equipment rack	✓	✓	✓	✓			
Equipment grounding conductor	✓	✓	✓	✓			✓
Individual system component chassis	✓	✓	✓	✓			✓
Control or Dispatch Centers electronic equipment and metallic parts of furniture	✓	✓	✓	✓			✓

WILLIAMSON COUNTY ESOC DATA CENTER COOLING UPGRADES

**ISSUED FOR CONSTRUCTION
JULY 20, 2023**

RAMIREZ-SIMON ENGINEERING, LLC
9805 Whithorn Drive
Houston, Texas 77095
Main: 832.261.1420
Texas Registered Engineering Firm F-14781

GESSNER ENGINEERING
Corporate Office: 401 W 26th Street,
Bryan, Texas, 77803
Main: 1.877.437.7637
Firm Registration Numbers: TBPE F-7451,
TBPLS F-10193910

Ramirez - Simon
 **Engineering, LLC**

Mechanical • Electrical • Plumbing
 Texas Registered Engineering Firm F-14781
 9805 Whithorn Dr. | Houston, TX 77095
 Office: 832.261.1420



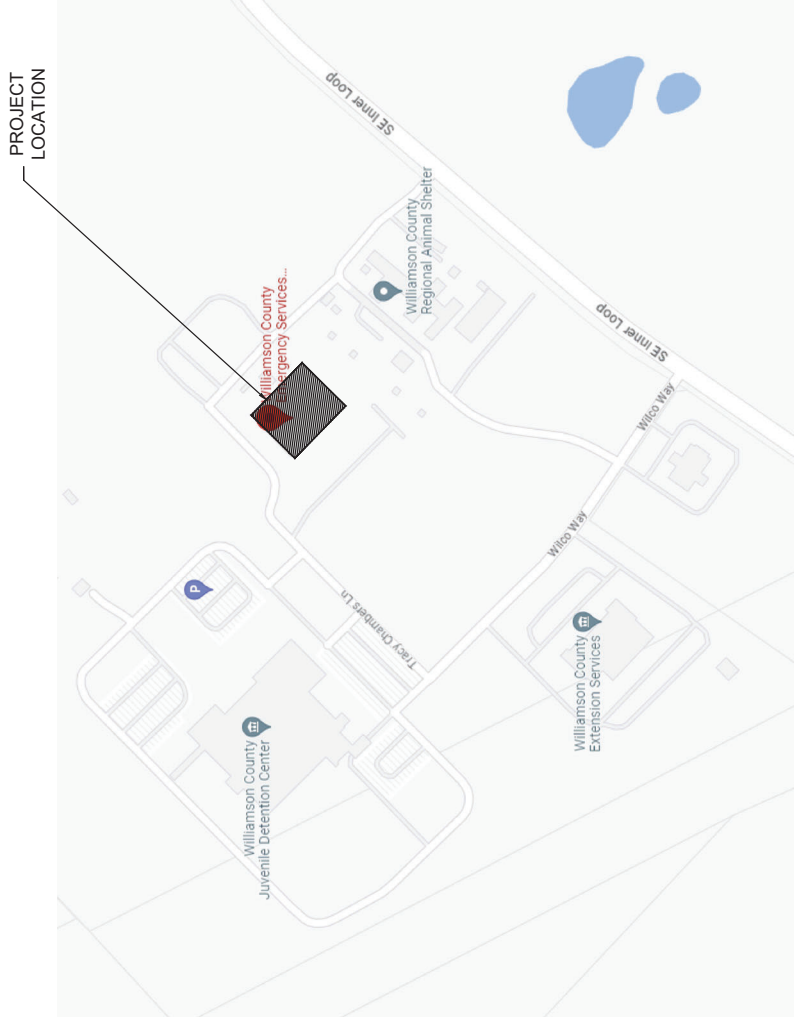
APPLICABLE CODES AND STANDARDS:

- NFPA 1 - FIRE CODE (2020)
NFPA 101 - LIFE SAFETY CODE (2020)
NFPA 72 - NATIONAL FIRE ALARM AND SIGNALING CODE (2020)
INTERNATIONAL BUILDING CODE (IBC 2021)
INTERNATIONAL FIRE CODE (IFC 2021)
INTERNATIONAL MECHANICAL CODE (IMC 2021)
INTERNATIONAL PLUMBING CODE (IPC 2021)
INTERNATIONAL ENERGY CONSERVATION CODE (IECC 2021)
NATIONAL ELECTRICAL CODE (NEC 2020)

ALTERNATES:

BASE BID: REPLACE EXISTING CRAC-1 WITH NEW CRAC-1, ADD ACCU-1 WITH ASSOCIATED CONCRETE PAD, AND PROVIDE ELECTRICAL.
ALTERNATE #1: REPLACE EXISTING CRAC-2 WITH NEW CRAC-2, ADD CRAC-4, ADD ACCU-2 AND ACCU-4, AND PROVIDE ELECTRICAL.
ALTERNATE #2: REPLACE EXISTING CRAC-3 WITH NEW CRAC-3, ADD ACCU-3, AND PROVIDE ELECTRICAL.
ALTERNATE #3: PROVIDE 20 TON TEMPORARY SUPPLEMENTAL COOLING AHU AND PROVIDE ELECTRICAL.

SHEET LIST	
SHEET NO.	SHEET TITLE
G001	GENERAL INFORMATION
S001	STRUCTURAL NOTES
S201	UNIT PAD FOUNDATION PLAN - BASE BID
S501	FOUNDATION DETAILS - BASE BID
M001	MECHANICAL LEGEND AND GENERAL INFORMATION
MD101	MECHANICAL DEMOLITION CRAWL SPACE PLAN - ALT #1
MD201	MECHANICAL DEMOLITION FLOOR PLAN - BASE BID AND ALTERNATES
M101	MECHANICAL RENOVATION CRAWL SPACE PLAN - BASE BID AND ALTERNATES
M201	MECHANICAL RENOVATION FLOOR PLAN - BASE BID AND ALTERNATES
M501	MECHANICAL DETAILS
M701	MECHANICAL SCHEDULES
M801	MECHANICAL CONTROLS
E001	ELECTRICAL LEGEND AND GENERAL INFORMATION
ED201	ELECTRICAL DEMOLITION PLAN - BASE BID AND ALTERNATES
E201	ELECTRICAL RENOVATION PLAN - BASE BID AND ALTERNATES
E501	ELECTRICAL DETAILS
E801	ELECTRICAL ONE LINE DIAGRAM AND SCHEDULES
E701	ELECTRICAL SCHEDULES



VICINITY MAP

CLIENT NAME:  WILLIAMSON COUNTY 1848

PROJECT NAME:
ESOC Data Center
Cooling Upgrades

RISE PROJECT NO.
1446

PROJECT ADDRESS:
911 Tracy Chambers Lane
Georgetown, TX 78626

ISSUED FOR
CONSTRUCTION
JULY 20, 2023

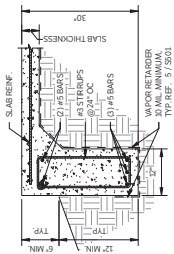
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GENERAL INFORMATION

SHEET NUMBER

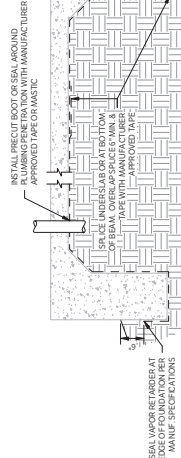
G001

- REINFORCEMENT NOTES:**
1. REINFORCEMENT PLANS FOR S.O.P.C.S. OR S.O.P.C.S. CONDITIONS.
 2. WHERE SLAB DROPS LESS THAN OR EQUAL TO 1/12" SLAB REINFORCEMENT MAY BE USED.
 3. VAPOR RETARDER AS DETAIL TO BE INSTALLED BELOW ALL FOUNDATION CONCRETE.
 4. ALL SPACES SHALL BE AS SPECIFIED IN THE GENERAL NOTES.
 5. REINFORCEMENT SHALL BE AS SPECIFIED IN THE GENERAL NOTES.
 6. BEAM AND SLAB DIMENSIONS TYPICAL UNLESS NOTED OTHERWISE.



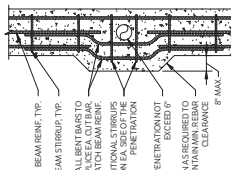
1. EXTERIOR BEAM
N.T.S.

- NOTE: VAPOR RETARDER AS DETAIL TO BE INSTALLED BELOW ALL FOUNDATION CONCRETE**



2. INTERIOR BEAM
N.T.S.

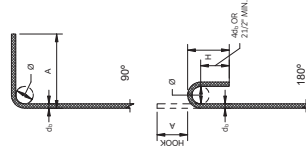
- NOTE: IF PIPE PENETRATION OCCURS CENTER OF THE BEAM & THE PIPE WIDTH IS GREATER THAN 1/2" THE CONTRADICTION MAY:**
1. NOT WIDEN THE BEAM.
 2. REPLACE BENT BARS W/ 2" HP DOVEL EACH SIDE OF PIPE.



3. VAPOR RETARDER DETAIL
N.T.S.

STANDARD DOVEL HOOK DIMENSIONS					
ALL GRADES OF STEEL					
BAR SIZE	Ø	90°	A	H	180°
#3	21/64"	0"	5"	4"	4"
#4	3"	0"	5"	7"	5"
#5	33/64"	0"	5"	7"	5"
#6	41/32"	12"	7"	8"	7"
#8	51/16"	14"	8"	11"	8"
#9	57/16"	15"	9"	12"	9"

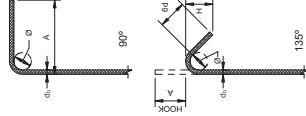
NOTE: Ø = FINISHED INSIDE BEND



4. STANDARD DOVEL HOOKS
N.T.S.

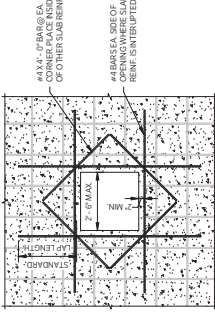
STIRRUPTIE HOOK DIMENSIONS					
ALL GRADES OF STEEL					
BAR SIZE	Ø	90°	A	H	135°
#3	11/32"	0"	41/4"	3"	3"
#4	31/8"	41/32"	41/2"	33/8"	3"
#5	31/8"	51/32"	51/2"	33/8"	3"
#6	41/16"	3"	41/2"	41/2"	41/2"
#8	51/16"	3"	5"	51/16"	5"
#9	57/16"	5"	101/16"	6"	6"

NOTE: Ø = FINISHED INSIDE BEND



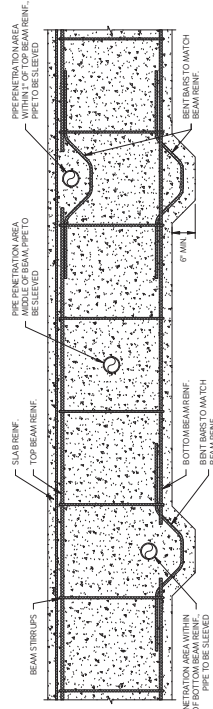
5. STIRRUPTIE HOOKS
N.T.S.

- NOTE: NO ADDITIONAL REINFORCEMENT IS REQUIRED FOR SINGLE OPENINGS LESS THAN 6" WIDE.**



6. SLAB OPENING REINFORCING
N.T.S.

- NOTE: WHEN PIPE SLEEVES WITHIN 1' OF BEAM REINFORCING BEAM REINFORCING SHALL BE STOPPED AND BENT BARS ADDED AS SHOWN BELOW.**



7. BEAM PENETRATION DETAIL
N.T.S.

Ramirez - Simon Engineering, LLC
Mechanical • Electrical • Plumbing
Texas Registered Engineering Firm F-14781
9805 Whithorn Dr. | Houston, TX 77095
Office: 832.281.1420



CONSULTANTS



GESSNER ENGINEERING
CONSULTANTS
10000 S. RICH AVE. SUITE 200
BRYAN, TEXAS 77803
bryan@gessnerengineering.com
www.gessnerengineering.com
FIRM REGISTRATION NUMBERS
TYPE F-160, BNA, F-16288910

PROJECT INFORMATION



WILLIAMSON CONSULTING
PROJECT NAME
ESOC Data Center Cooling Upgrades
RSE PROJECT NO.
1446
PROJECT ADDRESS
911 Tracy Chambers Lane
Georgetown, TX 78626

ISSUE

ISSUED FOR CONSTRUCTION
JULY 20, 2023

MARK DATE DESCRIPTION

RSE PROJECT NO. 1446
SHEET TITLE

FOUNDATION DETAILS - BASE BID

SHEET NUMBER

S501

FULL SIZE SHEET: 2204

PIPING SYMBOLS	
	PIPE UP
	PIPE DOWN
	PIPE CAP
	90° ELBOW
	RISE OR DROP IN ELEVATION
	TEEL OR BRANCH CONNECTION
	TEEDOWN
	CHILLED WATER SUPPLY
	CHILLED WATER RETURN
	CONDENSER WATER SUPPLY
	CONDENSER WATER RETURN
	HEATING WATER SUPPLY
	HEATING WATER RETURN
	FUEL OIL SUPPLY
	FUEL OIL RETURN
	CONDENSATE DRAIN LINE
	REFRIGERANT LINE
	15 PSC STEAM
	50 PSC STEAM
	80 PSC STEAM
	LOW PRESSURE CONDENSATE
	PUMPED CONDENSATE RETURN
	BALL VALVE
	GATE VALVE
	GLOBE VALVE
	2 WAY CONTROL VALVE
	3 WAY CONTROL VALVE
	2 WAY SOLENOID VALVE
	3 WAY SOLENOID VALVE
	BALANCING VALVE
	PRESSURE REDUCING VALVE
	CHECK VALVE
	SAFETY VALVE
	SUCTION DIFFUSER
	STRAINER
	STRAINER W/ BLOWDOWN
	PIPE REDUCER
	PET'S PLUG
	FLEXIBLE CONNECTION
	UNION
	COMPANION FLANGE
	AIR VENT - AUTOMATIC
	AIR VENT - MANUAL
	THERMOMETER
	PRESSURE GAUGE W/ GAUGE COCK
	FLOW METER
	PIPE ANCHOR
	PIPE EXPANSION JOINT
	PIPE GUIDE
	TRADE DUTY VALVE

NOTE: NOT ALL SYMBOLS MAY BE USED IN THIS PRESET

ABBREVIATIONS	
AD	ACCESS DOOR
AFB	ABOVE FINISHED FLOOR
AMP	AMPERE
BAS	BUILDING AUTOMATION SYSTEM
BBS	BRAKE HOSE/POWER
BOP	BOTTOM OF POLE
BTU	BRITISH THERMAL UNIT
CFM	CUBIC FEET PER MINUTE
CV	CONSTANT VOLUME
EAT	ENTERING AIR TEMPERATURE
(ETR)	EXITING AIR TEMPERATURE
EWI	EXISTING AIR TEMPERATURE
EWI	EXISTING WATER TEMPERATURE
FE	FEET PER MINUTE
FE	FIRE DAMPER
FSD	COMBINATION FIRE SMOKE DAMPER
FT	FEET PER MINUTE
FT	FEET
GPM	GALLONS PER MINUTE
HEPA	HIGH EFFICIENCY PARTICULATE AIR FILTER
HP	HORSE POWER
IN	INCHES
IN	INCHES PER HOUR
KWH	KILOWATT HOUR
LAT	LEAVING AIR TEMPERATURE
LWT	LEAVING WATER TEMPERATURE
MAT	MIXED AIR
MCD	MATCH IN VOLUME
NIC	NOT IN CONTRACT
NO	NUMBER (QUANTITY OR MODEL)
OA	OUTSIDE AIR
OA	OUTSIDE AIR PHASE
OR	OR UNFINISHED CONTRACTOR INSTALLED
PRV	PRESSURE REDUCING VALVE
PSIG	POUNDS PER SQUARE INCH GAGE
QTY	QUANTITY
RAF	RETURN AIR
RA	RETURN AIR
RH	RELATIVE HUMIDITY
RPM	REvolutions PER MINUTE
SP	STATIC PRESSURE (INCHES OF WATER)
TP	TOTAL PRESSURE (INCHES OF WATER)
TYP	TYPICAL
V	VOLTS
VAC	VOLTS ALTERNATING CURRENT
V	VARIABLE AIR VOLUME
VFD	VARIABLE FREQUENCY DRIVE
W	WATT

NOT ALL ABBREVIATIONS MAY BE USED ON THIS PROJECT.

MECHANICAL SYMBOLS		
	CEILING DIFFUSERS WITH ROUND RIBS DUCT CONNECTION	
	CEILING DIFFUSERS WITH ROUND FLEX DUCT CONNECTION	
	CEILING SUPPLY AIR DEVICE (24x24 and 12x12)	
	CEILING RETURN AIR DEVICE (24x24 and 12x12)	
	CEILING EXHAUST AIR DEVICE (24x24 and 12x12)	
	1 WAY THROW CEILING AIR DEVICE	
	2 WAY THROW CEILING AIR DEVICE	
	3 WAY THROW CEILING AIR DEVICE	
	SIDEWALL EXHAUST OR RETURN AIR GRILLE OR REGISTER	
	SIDEWALL SUPPLY REGISTER	
	MANUAL VOLUME DAMPER	
	MOTORIZED DAMPER	
	FIRE DAMPER	
	COMBINATION PRESSURE SMOKE DAMPER	
	SMOKE DAMPER	
	DUCT MOUNTED SMOKE DETECTOR	
	FLEXIBLE DUCT CONNECTION	
	DUCT TRANSITION	
	DUCT TRANSITION FROM RECTANGULAR TO ROUND	
	DUCT RISE IN DIRECTION OF AIRFLOW	
	DUCT DROP IN DIRECTION OF AIRFLOW	
	VANED ELBOW (PROVIDE ALL SQUARE OR RECTANGULAR ELBOWS WITH VANES EXCEPT TRANSFER AIR SOUND ELBOW)	
	LONG RADIUS DUCT ELBOW	
	AIR DUCT SPLITTER	
	ACOUSTICAL FIBER FREE LINED DUCT	
	BRANCH CONNECTION TO MAN WITH VOLUME DAMPER (ALL BRANCH DUCTWORK TO MAN OR AIR DEVICE SHALL HAVE VOLUME DAMPERS UNLESS OTHERWISE NOTED)	

MECHANICAL SYMBOLS		
	SUPPLY DUCT UP DOWN	
	RETURN DUCT UP DOWN	
	EXHAUST DUCT UP DOWN	
	INDICATED 24x24 RECTANGULAR DUCT INDICATED 12x12 ROUND DUCT INDICATED 24x24 FLAT OVAL	
	ACCESS DOOR	
	HUMIDISTAT OR TEMPERATURE SENSOR (SEE CONTROLS)	
	HUMIDISTAT OR HUMIDITY SENSOR (SEE CONTROLS)	
	MAGNAHELIC GAUGE	
	STATIC PRESSURE SENSOR	
	CARBON DIOXIDE SENSOR	
	CARBON MONOXIDE SENSOR	
	DIFFERENTIAL PRESSURE SENSOR	
	OCCUPANCY SENSOR (REFER TO ELECT FOR MORE INFO)	
	THERMOSTAT CONTROL WIRE	
	EXISTING TO BE DEMOLISHED	
	EXISTING TO REMAIN	
	NEW CONSTRUCTION	
	CONNECT AT THIS POINT	
	REMOVE TO THIS POINT	
	AIR DEVICE TAG DENOTING CHM. QUANTITY AND SCHEDULES 12x12 SUPPLY 24x24 RETURN 24x24 EXHAUST	
	EQUIPMENT TAG LEGEND ACCH-1M - EQUIPMENT TAG M - MODEL SCHOOL P - CHILLED WATER PUMP E - ELEMENTARY SCHOOL	
	EQUIPMENT — EQUIPMENT CLEARANCE	
	SECTION CALLOUT SYMBOL SECTION NUMBER — SHEET NUMBER — (A-01)	
	GENERAL CALLOUT SYMBOL ENLARGED PLAN DETAIL NUMBER — ENLARGED PLAN SHEET NUMBER — (A-01)	

MECHANICAL SYMBOLS		
	CEILING DIFFUSERS WITH ROUND RIBS DUCT CONNECTION	
	CEILING DIFFUSERS WITH ROUND FLEX DUCT CONNECTION	
	CEILING SUPPLY AIR DEVICE (24x24 and 12x12)	
	CEILING RETURN AIR DEVICE (24x24 and 12x12)	
	CEILING EXHAUST AIR DEVICE (24x24 and 12x12)	
	1 WAY THROW CEILING AIR DEVICE	
	2 WAY THROW CEILING AIR DEVICE	
	3 WAY THROW CEILING AIR DEVICE	
	SIDEWALL EXHAUST OR RETURN AIR GRILLE OR REGISTER	
	SIDEWALL SUPPLY REGISTER	
	MANUAL VOLUME DAMPER	
	MOTORIZED DAMPER	
	FIRE DAMPER	
	COMBINATION PRESSURE SMOKE DAMPER	
	SMOKE DAMPER	
	DUCT MOUNTED SMOKE DETECTOR	
	FLEXIBLE DUCT CONNECTION	
	DUCT TRANSITION	
	DUCT TRANSITION FROM RECTANGULAR TO ROUND	
	DUCT RISE IN DIRECTION OF AIRFLOW	
	DUCT DROP IN DIRECTION OF AIRFLOW	
	VANED ELBOW (PROVIDE ALL SQUARE OR RECTANGULAR ELBOWS WITH VANES EXCEPT TRANSFER AIR SOUND ELBOW)	
	LONG RADIUS DUCT ELBOW	
	AIR DUCT SPLITTER	
	ACOUSTICAL FIBER FREE LINED DUCT	
	BRANCH CONNECTION TO MAN WITH VOLUME DAMPER (ALL BRANCH DUCTWORK TO MAN OR AIR DEVICE SHALL HAVE VOLUME DAMPERS UNLESS OTHERWISE NOTED)	

NOTE: NOT ALL SYMBOLS MAY BE USED ON THIS PROJECT.

GENERAL NOTES

1. THESE NOTES APPLY TO ALL MECHANICAL SHEETS.
2. PROVIDE ACCESS DOORS ON WALLS, CEILING OR CHASES TO ACCESS CONCEALED VALVES, ADJUSTABLE EQUIPMENT AND CONTROL DEVICES. REFER TO SPECIFICATIONS FOR SCHEDULING OF ACCESS DOORS. ACCESS DOORS SHALL MATCH CLASSIFICATION OF WALL AND CEILING RATING.
3. FURNISH ALL NECESSARY STRUCTURES, INSERTS, SLEEVES, AND HANGING DEVICES FOR INSTALLATION OF MECHANICAL EQUIPMENT, DUCTWORK, PIPING, ETC. PROVIDE ALL NECESSARY PENETRATIONS, JOINTS, AND CONTACTS TO AND FROM MAIN EQUIPMENT ACCESS AND SERVICE VENTS.
4. PROVIDE ALL NECESSARY MISCELLANEOUS ANGLES, CHANNELS, UNITS, ETC. AS REQUIRED TO ADEQUATELY SUPPORT THE MECHANICAL PIPING, DUCTWORK, AND EQUIPMENT. COORDINATE WITH STRUCTURAL.
5. DETAILS ELUSTRATED ON THE DRAWINGS SHALL BE APPLIED IN ALL CASES WHERE THE FUTURE OCCUPANTS WILL BE UNKNOW.
6. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ALL NECESSARY PENETRATIONS IS RESPONSIBLE FOR COORDINATING ALL PIPING WITH OTHER TRADES AND PROVIDING OFFSETS IN PIPINGS AS REQUIRED. ALL PIPE SHALL BE ROUTED AS CLOSE TO STRUCTURE AS POSSIBLE.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ALL NECESSARY PENETRATIONS. SUCH PENETRATIONS MAY DEVIATE FROM AISC CONFIGURATION.
8. ALL PIPING DUCTS SHOWN ARE NOMINAL. DIMENSION IS REQUIRED. A PIPE RATING EXTERNALLY INSTALLED CONTRACTOR IS REQUIRED TO COORDINATE ACTUAL PIPE RATING AND SIZING AS NECESSARY FOR MAINTAINING REQUIRED CLEARANCES IN ALL CASES.
9. MAJOR EQUIPMENT SHOWN ON THE P AND E ELEVATIONS ILLUSTRATE THE GENERAL ARRANGEMENT AND SPACE ALLOCATIONS. CONTRACTOR SHALL VERIFY THE SPACE REQUIREMENTS FOR EACH SYSTEM COMPONENT USING MANUFACTURER'S DATA. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ALL NECESSARY PLACEMENT AND CONNECTION IN ORDER TO ACCOMMODATE THE EXACT EQUIPMENT INSTALLED.
10. COORDINATE ALL PIPING WITH STRUCTURAL, AND MECHANICAL SYSTEMS AND PROVIDE ALL NECESSARY PENETRATIONS TO AVOID CONFLICTS AND TO MAINTAIN EQUIPMENT ACCESS AND SERVICEABILITY.
11. CONTRACTOR INSTALLER SHALL NOTIFY COUNTY OF ANY EXISTING NON-CONFORMING NON-CODE COMPLIANT INSTALLATIONS OR LIFE-SAFETY CONCERNS UNCOVERED OR WHETHER OR NOT THEY ARE WITHIN OR OUTSIDE THE CONTRACTUAL SCOPE OF WORK.
12. CONTRACTOR SHALL MAINTAIN THE LIFE PROTECTION SYSTEM OF THE ENTIRE BUILDING IN WORKING ORDER FOR THE DURATION OF THE PROJECT. NOTIFY COUNTY OF ANY LIFE PROTECTION SYSTEM UNCOVERED OR WHETHER OR NOT OUTSIDE THE CONTRACTUAL SCOPE OF WORK.

 Ramirez & Simon Engineering, LLC	Mechanical • Electrical • Plumbing Texas Registered Engineering Firm F-14781 9805 Wilhomm Dr., Houston, TX 77095 Office 832.261.1420	SEAL  <i>Mark C. LaFollette</i> 07/25/2023	CONSULTANTS  GESSNER ENGINEERING CORPORATE OFFICE 401 W 26TH STREET HOUSTON, TEXAS 77018 1377 GESSNER (407.9637) www.gessnerengineering.com PH: 281.440.7400 FAX: 281.440.8885 FIRM LICENSE NO. 1400000000000000	PROJECT INFORMATION CLIENT NAME  WILLIAMSON COUNTY 1848	PROJECT NAME ESOC Data Center Cooling Upgrades BASE PROJECT NO. 1446	PROJECT ADDRESS 911 Tracy Chambers Lane Georgetown, TX 78626

[illegible]

	PIPE GUIDE
	TRIPLE DUTY VALVE

NOTE: NOT ALL SYMBOLS MAY BE USED IN THIS PROJECT.

GENERAL NOTES

- A. REPLACE ONE CRAC UNIT AT A TIME TO INSURE THAT SPACE IS CONDITIONED.

SHEET KEYED NOTES

- DISCONNECT EXISTING SMOKE DETECTOR CONTROLLER, TO MAKE ROOM FOR NEW CRACK UNIT. RELOCATE EXISTING SMOKE DETECTOR TO NEW CRACK (RE 0001).
1. ASSEMBLE CRACK PIPING FROM CRACK UNIT BACK TO FLOOR PENETRATION.
2. ASSEMBLE CRACK PIPING FROM CRACK UNIT AND STAND ALONG WITH EXISTING CRACK PIPING FROM CRACK UNIT BACK TO FLOOR PENETRATION.
3. TERMINATE #1 DEMOLISH EXISTING CRACK UNIT AND STAND ALONG WITH ASSOCIATED CRACK PIPING FROM CRACK UNIT BACK TO FLOOR PENETRATION.
4. ALTERNATE #2 DEMOLISH EXISTING CRACK UNIT AND STAND ALONG WITH EXISTING CRACK PIPING FROM CRACK UNIT BACK TO FLOOR PENETRATION.
5. ASSEMBLE DEMOLISHED EXISTING CONDENSATE PIPING BACK TO MAIN.
6. ALTERNATE #1 DEMOLISH EXISTING CONDENSATE PIPING BACK TO MAIN.
7. ALTERNATE #2 DEMOLISH EXISTING CONDENSATE PIPING BACK TO MAIN.
8. EXISTING FLOOR DRAIN SHALL REMAIN.
9. EXISTING EQUIPMENT TO REMAIN.
10. ALTERNATE #1 DEMOLISH EXISTING CHILLED WATER PIPING TO PROVIDE

2. BASE BID: DEMOLISH EXISTING CRAC-1 UNIT AND STAND ALONG WITH ASSOCIATED CHSR PIPING FROM CRAC UNIT BACK TO FLOOR PENETRATION.

1. ALTERNATE #1: DEMOLISH EXISTING CRAC-2 UNIT AND STAND ALONG WITH ASSOCIATED CHSR PIPING FROM CRAC UNIT BACK TO FLOOR RENOVATION

4. ALTERNATE #2: DEMOLISH EXISTING CRAC-3 UNIT AND STAND ALONG WITH EXISTING CHSR PIPING FROM CRAC UNIT BACK TO FLOOR.

- BASERID: DEMOLISH EXISTING CONDENSATE PIPING BACK TO MAIN

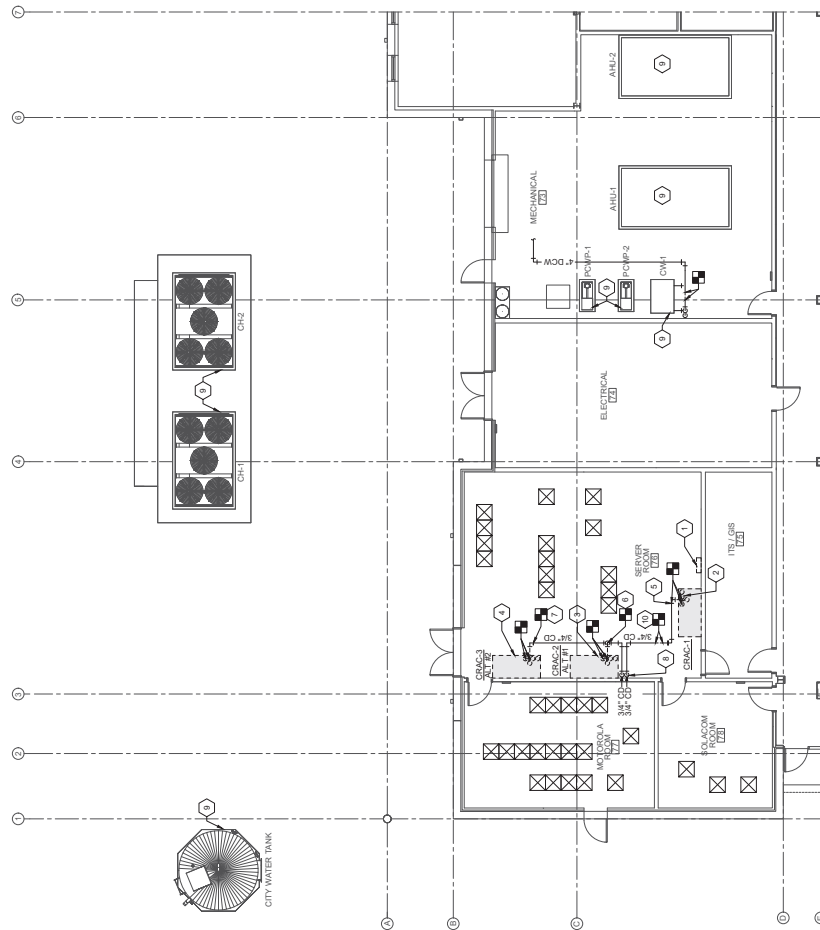
- ALTERNATE #1: DEMOLISH EXISTING CONDENSATE PIPING BACK TO MAIN

7. ALTERNATE #2: DEMOLISH EXISTING CONDENSATE PIPING BACK TO MAIN

1. EXISTING FLOOR DRAIN SHALL REMAIN.

9. EXISTING EQUIPMENT TO REMAIN.

0. ALTERNATE #1: DEMOLISH EXISTING CHILLED WATER PIPING TO PROVIDE ROOM FOR NEW CHILLED WATER PIPING CONNECTION.



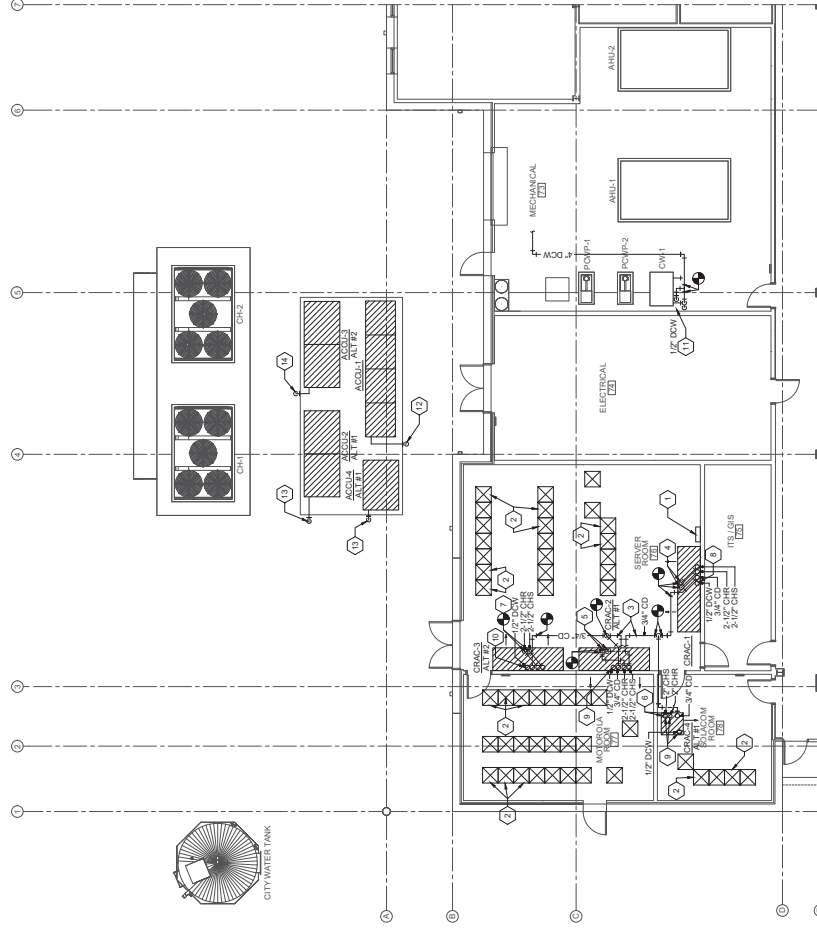
FULL SIZE SHEET: 22X34

GENERAL NOTES

- A. ALTERNATE #3: CONTRACTOR IS RESPONSIBLE FOR PROVIDING 20 TON TEMPORARY SUPPLEMENTAL COOLING AHU TO CONDITION SPACE DURING CONSTRUCTION. ROUTE TEMPORARY AHU DUCTWORK TO EXTERNAL DOOR OPENING AND FRAME OUT OPENING. SPACE TEMPERATURE MUST BE MAINTAINED AT SETPOINT REGARDLESS OF CONSTRUCTION PHASE.

SHEET KEYED NOTES

1. BASE BID: RELOCATE EXISTING DETECTOR CONTROL AND RECONNECT CRAC UNITS TO EXISTING DETECTOR AND CONTROLLING WIRING.
2. BASE BID: CONTRACTOR SHALL INSTALL LOW VOLTAGE FURNISHED SUPPLY DIFFUSERS IN RAISED FLOOR, SLA W/ME FLOOR TILES AND TURN OVER TO OWNER.
3. EXISTING CONDENSATE ROUTED BELOW FLOOR TO FLOOR DRAIN.
4. BASE BID: UTILITY EXISTING CHASER RISER UP THOUGH EXISTING FLOOR PENETRATION, OFFSET NEW CHASER AS REQUIRED TO CONNECT TO EXISTING FLOOR PENETRATION, AND BELOW BASED FLOOR. REFER TO 1M101 FOR CONTINUATION.
5. ALTERNATE A: UTILITY EXISTING CHASER RISER UP THOUGH EXISTING FLOOR PENETRATION, OFFSET NEW CHASER AS REQUIRED TO CONNECT TO EXISTING FLOOR PENETRATION, AND BELOW BASED FLOOR. REFER TO 1M101 FOR CONTINUATION.
6. ALTERNATE A: UTILITY EXISTING CHASER RISER UP THOUGH EXISTING FLOOR PENETRATION, OFFSET NEW CHASER AS REQUIRED TO CONNECT TO EXISTING FLOOR PENETRATION, AND BELOW BASED FLOOR. REFER TO 1M101 FOR CONTINUATION.
7. ALTERNATE A: UTILITY EXISTING CHASER RISER UP THOUGH EXISTING FLOOR PENETRATION, OFFSET NEW CHASER AS REQUIRED TO CONNECT TO NEW CRAC/AMOVAS AND BELOW BASED FLOOR. REFER TO 1M101 FOR CONTINUATION.
8. BASE BID: CONDENSATE NEW FLOOR PENETRATION OR NEW PIPING. REFER TO 1M101 FOR CONTINUATION.
9. ALTERNATE A: CRAC OR DRILL NEW FLOOR PENETRATION FOR NEW PIPING. REFER TO 1M101 FOR CONTINUATION.
10. ALTERNATE A: CRAC OR DRILL NEW FLOOR PENETRATION FOR NEW PIPING. REFER TO 1M101 FOR CONTINUATION.
11. BASE BID: PROVIDE NEW DOMESTIC COLD WATER TO CRAC UNIT FOR HUMIDIFICATION, ROUTE PIPING THOUGH CRAWL SPACE, CRAC DRI LL NEW FLOOR PENETRATION. REFER TO 1M101 FOR CONTINUATION.
12. BASE BID: REFRIGERANT PIPING SHALL BE ROUTED UNDERGROUND. REFER TO 1M101 FOR REFRIGERANT PIPING CONTINUATION.
13. ALTERNATE A: REFRIGERANT PIPING SHALL BE ROUTED UNDERGROUND. REFER TO 1M101 FOR REFRIGERANT PIPING CONTINUATION.
14. ALTERNATE A: REFRIGERANT PIPING SHALL BE ROUTED UNDERGROUND. REFER TO 1M101 FOR REFRIGERANT PIPING CONTINUATION.



MECHANICAL RENOVATION FLOOR PLAN - BASE BID AND ALTERNATES



C

SEAL



CONSULTANTS



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FIRM REGISTRATION NUMBERS:
TYPE F-7461, TYP F-1095980

PROJECT INFORMATION

CLIENT NAME



PROJECT NAME:
ESOC Data Center
Cooling Upgrades
RSE PROJECT NO.:
1446
PROJECT ADDRESS:
911 Tracy Chambers Lane
Georgetown, TX 78626

ISSUE

**ISSUED FOR
CONSTRUCTION**
JULY 20, 2023

DATE

DESCRIPTION

RSE PROJECT NO. 1446

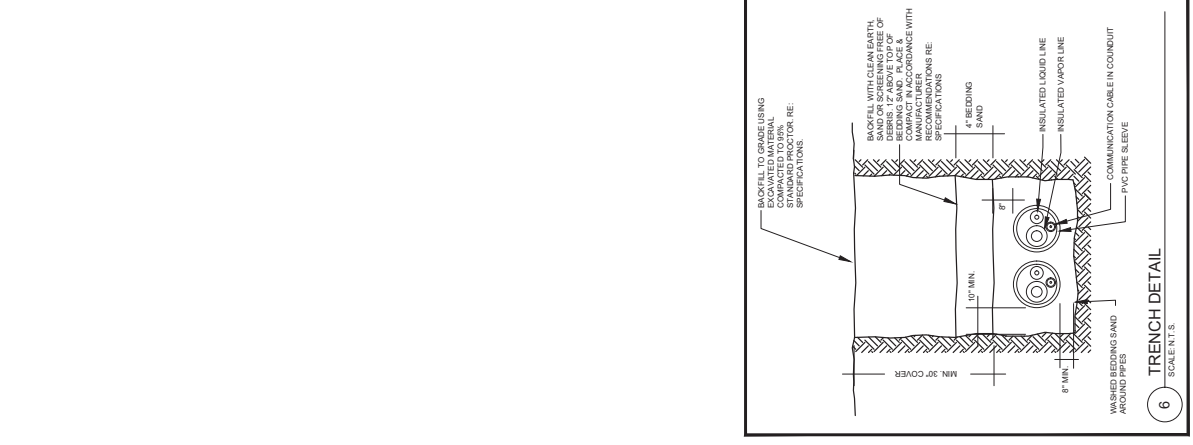
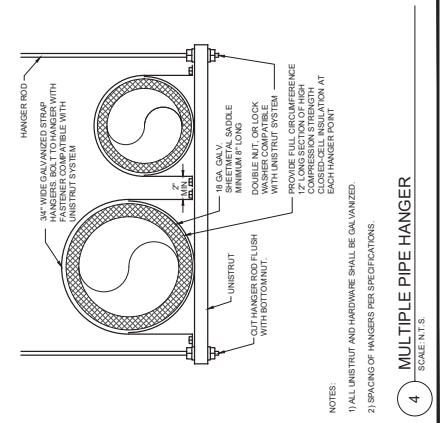
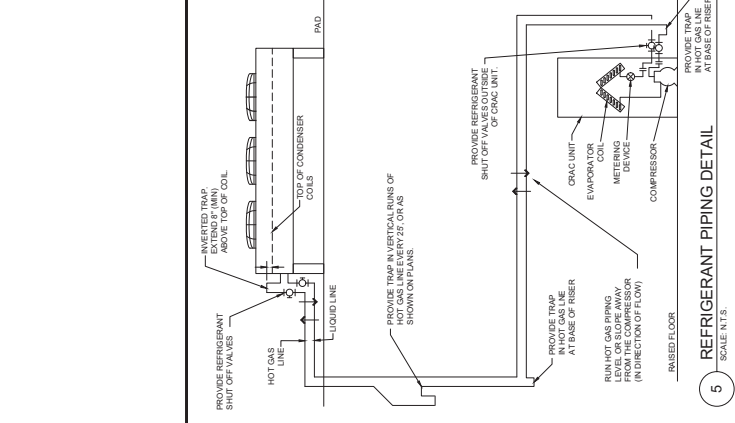
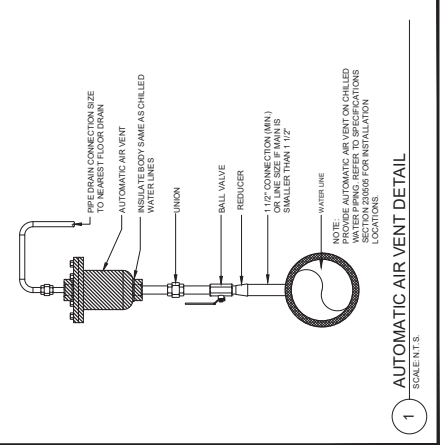
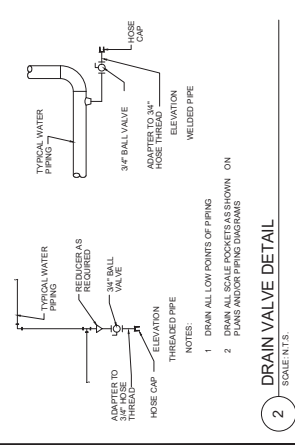
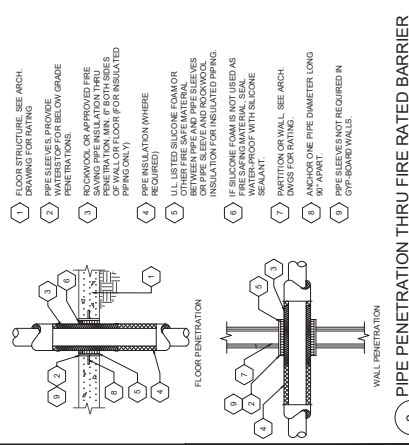
SHEET TITLE

**MECHANICAL
DETAILS**

SHEET NUMBER

M501

FULL SIZE SHEET 22"X34"



C

B

A

CRAC UNIT SCHEDULE

CRAC UNIT SCHEDULE																										
GENERAL				SUPPLY FAN				DX COOLING COIL						CHILLED WATER COOLING COIL						ELECTRIC REPEAT		HUMIDIFIER (INFRARED)	ELECTRICAL			REMARKS
UNIT TAG	AREA SERVED	MANUFACTURER	MODEL	SACFM	BHP/PER FAN	ESP (INCHES)	NUMBER OF FANS	TOTAL LOAD (BTU/H)	SENSIBLE LOAD (BTU/H)	EAT DB TEMP. (°F)	EAT WB TEMP. (°F)	FLOW RATE (GPM)	PRESSURE DROP (FT)	STEPS	POWER (KW)	CAPACITY (LBS PER HOUR)	NCA	NOCOP	WPH/2	WEIGHT LBS.	REMARKS					
CRAC-1 (BASE BID)	SERVER ROOM	LEBERT	DS10SDUAE1E	12,600	0.2	3.6	3	310,000	298,000	75	61	255,000	246,000	14	3	30	22	97.4	110	4603/60	3300	ALL				
CRAC-2 (ALT - #1)	SERVER ROOM	LEBERT	DS10SDUAE1E	10,000	0.2	4.15	2	272,500	238,600	75	61	194,000	184,000	14	3	25	22	74.8	60	4603/60	2800	ALL				
CRAC-3 (ALT - #2)	MOTOROLA ROOM	LEBERT	DS10SDUAE1E	10,000	0.2	4.15	2	272,500	238,600	75	61	194,000	184,000	14	3	25	22	74.8	60	4603/60	2600	ALL				
CRAC-4 (ALT - #1)	SOLACOM ROOM	LEBERT	DS077DUAEBS0	3,900	0.2	4.15	1	97,500	86,200	75.0	61.0	76,500	71,200	8.4	3	12	7.7	43.7	50	4603/60	1,000	ALL				

NOTES:

1. PROVIDE UNIT WITH SINGLE POINT ELECTRICAL CONNECTION AND LOCKING DISCONNECT
2. PROVIDE UNIT MOUNTED RECEPTACLE. CONDUIT AND WIRING SHALL BE PROVIDED BY ELECTRICAL CONTRACTOR
3. PROVIDE UNIT WITH 4" VIEW'S OF FILTERS.
4. UNIT TO HAVE INTERNAL VIBRATION SOLUTION.
5. INTERNAL SWITCH INCLUDES WET COIL, CASING LOSSES, COILS, FILTERS AND INTEGRAL GRILLES.
6. PROVIDE SMOKE DETECTOR AT UNIT RETURN AIR OPENING.
7. PROVIDE BACKET P INTERFACE CARD.
8. PROVIDE WITH 2nd FLOOR STAND AND SUPPLY WINE INTO RAISED FLOOR.
9. MANUFACTURER TO PROVIDE AND INSTALL NETWORK BETWEEN UNITS.
10. PROVIDE DRAIN PAN AND OVERFLOW CONDENSATE SWITCH.

AIR COOLED CONDENSER SCHEDULE

AIR COOLED CONDENSER SCHEDULE											
GENERAL				TOTAL COOLING LOAD (BTUH)		OUTDOOR CONDITIONS		ELECTRICAL		REMARKS	
UNIT TAG	ASSOCIATED AHU	MFGR.	MODEL	SUMMER DB TEMP. (°F)	WINTER DB TEMP. (°F)	IPVPHAZ	MCA	MOCP			
ACCU-1 (BASE BID)	CRAC-1	LEBERT	MCM10E8AD	310,000	105.0	25.0	460/960	6	15	1700	ALL
ACCU-2 (ALT-#1)	CRAC-2	LEBERT	MCL110E8AD	272,800	105.0	25.0	460/960	6.3	15	1000	ALL
ACCU-3 (ALT-#2)	CRAC-3	LEBERT	MCL110E8AD	272,800	105.0	25.0	460/960	6.3	15	1000	ALL
ACCU-4 (ALT-#1)	CRAC-4	LEBERT	MCL095E1AD	97,500	105.0	25.0	460/960	3.5	15	750	ALL

NOTES:

1. MOUNT AND ANCHOR ON DEDICATED 6" CONCRETE PAD
2. WITH REFRIGERANT 410A
3. WITH DISCONNECT SWITCH.
4. PROVIDE EXPANSION VALVE TXV FOR COOLING.
5. COMPRESSOR DISCHARGE TEMPERATURE SENSOR.
6. SUCTION TEMPERATURE SENSOR.
7. FIELD INSTALLED FILTER DRYER.
8. INTERNAL CRANKCASE HEATER.

Mechanical • Electrical • Plumbing
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12

1000



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FIRM REGISTRATION NUMBERS:
T89E-F-7451, T89I-S-F-10193910

PROJECT INFORMATION

1100316 2013 0000

CLIENT NAME:



PROJECT NAME:
ESOC Data Center
Cooling Upgrades

RSE PROJECT No.
1446

PROJECT ADDRESS:
911 Tracy Chambers Lane
Georgetown TX 78626

100

ISSUED FOR
CONSTRUCTION
JULY 20, 2023

[illegible]

MECHANICAL SCHEDULES

SHEET NUMBER

M701

[illegible]

REFERENCE	
SYMBOL	DEFINITION
	KEYED NOTE REFERENCE
	MECHANICAL EQUIPMENT REFERENCE
	DIMETRIC MOUNTING HEIGHT AFFIX REFERENCE
	KITCHEN EQUIPMENT REFERENCE
	MEDICAL EQUIPMENT REFERENCE
GENERAL DRAWING SYMBOLS	
	DETAIL
	SECTION
	NORTH ARROW
	SCALE BAR

DEMOLITION LEGEND

	DASHED, DARK SYMBOL INDICATES EXISTING DEVICE OR EQUIPMENT TO BE REMOVED.
	SOLID, LIGHT SHADED SYMBOL INDICATES EXISTING DEVICE OR EQUIPMENT TO REMAIN.

[illegible]

ONE-LINE DIAGRAM SYMBOLS

WIRELESS COMMUNICATIONS

10000
30000
50000
70000
90000
110000
130000
150000
170000
190000
210000
230000
250000
270000
290000
310000
330000
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430000
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730000
750000
770000
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810000
830000
850000
870000
890000
910000
930000
950000
970000
990000

ONE-LINE DIAGRAM SYMBOLS

DESCRIPTION

CONDUCTOR (WIRE) (RIGID)
PAIRED SETTING AND
TIGHTENING IN SPECIFICATION
ON CONDUITS

CURRENT TRANSFORMER, NUMBER
10000 DENOTES RATIO
30000 DENOTES RATIO
50000 DENOTES RATIO
70000 DENOTES RATIO
90000 DENOTES RATIO
110000 DENOTES RATIO
130000 DENOTES RATIO
150000 DENOTES RATIO
170000 DENOTES RATIO
190000 DENOTES RATIO
210000 DENOTES RATIO
230000 DENOTES RATIO
250000 DENOTES RATIO
270000 DENOTES RATIO
290000 DENOTES RATIO
310000 DENOTES RATIO
330000 DENOTES RATIO
350000 DENOTES RATIO
370000 DENOTES RATIO
390000 DENOTES RATIO
410000 DENOTES RATIO
430000 DENOTES RATIO
450000 DENOTES RATIO
470000 DENOTES RATIO
490000 DENOTES RATIO
510000 DENOTES RATIO
530000 DENOTES RATIO
550000 DENOTES RATIO
570000 DENOTES RATIO
590000 DENOTES RATIO
610000 DENOTES RATIO
630000 DENOTES RATIO
650000 DENOTES RATIO
670000 DENOTES RATIO
690000 DENOTES RATIO
710000 DENOTES RATIO
730000 DENOTES RATIO
750000 DENOTES RATIO
770000 DENOTES RATIO
790000 DENOTES RATIO
810000 DENOTES RATIO
830000 DENOTES RATIO
850000 DENOTES RATIO
870000 DENOTES RATIO
890000 DENOTES RATIO
910000 DENOTES RATIO
930000 DENOTES RATIO
950000 DENOTES RATIO
970000 DENOTES RATIO
990000 DENOTES RATIO

SYMBOL	DEVICES SYMBOLS
	DEVICE INSTALLATION BELOW, "X" EQUALS 1000 (SEE NOTE 1)
	STAND FOR NORMAL POWER (SEE NOTE 1)
	G GROUND
	GB GROUND AND BOND
	GB GROUND AND BOND WWP WEATHERPROOF AND GFCI
	FLOOR DUPLEX RECEPTACLE CONFIGURATION AS NOTED ON PLANS
	FLOOR DUPLEX RECEPTACLE CONFIGURATION AS NOTED ON PLANS
	FLOOR DUPLEX RECEPTACLE CONFIGURATION AS NOTED ON PLANS DIMENSIONS AS NOTED ON PLANS
	CEILING MOUNTED DUPLEX RECEPTACLE
	CEILING MOUNTED DOUBLE DUPLEX RECEPTACLE
	DOUBLE DUPLEX RECEPTACLE
	EMERGENCY DUPLEX RECEPTACLE
	SPECIAL PURPOSE RECEPTACLE, NEMA NOTED ON PLANS AND AMPERE AND VOLTAGE NOTED ON PLANS
	GROUND, RECIRCULATED SAMPLE
	FLOOR MOUNTED DUPLEX RECEPTACLE AND TWO GANG OUTLET (SURFACES MOUNTED RECEPTACLE) CONFIGURATION AS NOTED ON PLANS
	WALL MOUNTED CODE SIZE J BOX
	WALL MOUNTED CODE SIZE J BOX WITH EQUIPMENT
	CODE SIZE JUNCTION BOX
	CODE SIZE PULL BOX
	PUSH BUTTON
	PHOTOCELL
	LIGHTNING PROTECTION AIR TERMINAL
	THERMOSTAT
	ENCLOSED CIRCUIT BREAKER
	NON-ARCHED ENCLOSURE RATING
	ARCHED ENCLOSURE RATING
	FIXED DISCONNECT SWITCH
	MOTOR STARTER, STARTER SIZE
	COMBINATION DISCONNECT SWITCH AND MOTOR STARTER, NEMA STARTER DESIGNATION, 3 POLE UNIT
	HOSEPOWER RATING FOR HP AND MOTOR, 1/400HP
	MOTOR, 1/400HP

	HORSEPOWER
	NOTE: NOT ALL ABBREVIATIONS, SYMBOLS OR GENERAL NOTES APPLY TO THIS PROJECT

FIRE ALARM SYMBOLS			SYMBOL	DESCRIPTION	UNIT
FA	FA	FA	FIRE ALARM NOTIFICATION PANEL	WALL	-
FA	FA	FA	FULL STATION	WALL	44"
FA	FA	FA	NOTIFICATION SPEAKER	WALL	40"
FA	FA	FA	CHIME NOTIFICATION	WALL	40"
FA	FA	FA	COMBINATION SPEAKER AND CHIME NOTIFICATION	WALL	40"
FA	FA	FA	SPRINKLER WORK WITH FIREARM LIGHT	WALL	40"
FA	FA	FA	SPRINKLER WORK ONLY	WALL	40"
FA	FA	FA	BELL (GONG)	WALL	40"
FA	FA	FA	PHOTOCRYSTALINE SMOKE DETECTOR	CEILING	SMOKE DETECTOR
FA	FA	FA	IONIZATION SMOKE DETECTOR	CEILING	SMOKE DETECTOR
FA	FA	FA	BEAM TRANSMITTER	CEILING	SMOKE DETECTOR
FA	FA	FA	BEAM RECEIVER	CEILING	SMOKE DETECTOR
FA	FA	FA	COMBINATION RATE OF FIRE PIVOT TEMPERATURE SMOKE DETECTOR	CEILING	SMOKE DETECTOR
FA	FA	FA	NOTED ON PLANS OR SPECIFICATIONS	CEILING	SMOKE DETECTOR
FA	FA	FA	HEAT OF FIRE ONLY	CEILING	SMOKE DETECTOR
FA	FA	FA	UNDER FLOOR SMOKE DETECTOR	FLOOR	SMOKE DETECTOR
FA	FA	FA	DUCT DETECTOR	DUCT	SMOKE DETECTOR
FA	FA	FA	FIREMAN'S DAMPER	DUCT	SMOKE DETECTOR
FA	FA	FA	PRESSURE SWITCH	PIPE	SMOKE DETECTOR
FA	FA	FA	TAMPER SWITCH	PIPE	SMOKE DETECTOR
FA	FA	FA	FLOW SWITCH	PIPE	SMOKE DETECTOR
FA	FA	FA	POST INDICATION VALVE	PIPE	SMOKE DETECTOR
FA	FA	FA	MAGNETIC DOOR HOLDER	DOOR	SMOKE DETECTOR
FA	FA	FA	CONTROL MODULE	DOOR	SMOKE DETECTOR
FA	FA	FA	MONITOR MODULE	DOOR	SMOKE DETECTOR
FA	FA	FA	REMOTE ALARM INDICATING LIGHT	DOOR	SMOKE DETECTOR
FA	FA	FA	ADDRESSABLE SUPERVISED RELAY	DOOR	SMOKE DETECTOR

[illegible]

Ramirez - Simon
 **Engineering, LLC**

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 9805 Whithorn Dr. | Houston, TX 77095
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BRYAN, TEXAS 77803
1.877.GESSNER (437.7637)
www.gessnerengineering.com

FIRM REGISTRATION NUMBER



WILLIAMSON
COUNTY

PROJECT NAME:
ESOC Data Center
Cooling Upgrades

RSE PROJECT No.
1446

PROJECT ADDRESS:
911 Tracy Chambers

ISSUE		ISSUED FOR CONSTRUCTION JULY 20, 2023		E001	
MARK	DATE	DESCRIPTION	RUE PROJECT NO. 148		SHEET NUMBER
			SHEET TITLE		
					ELECTRICAL LEGEND AND GENERAL INFORMATION

GENERAL NOTES

A. REFER TO ELECTRICAL LEGEND SHEET FOR PROJECT GENERAL NOTES.

B. ALL EXISTING EQUIPMENT SHOWN IS EXISTING TO REMAIN UNLESS OTHERWISE NOTED.

KEYED NOTES

1. REMOVE EXISTING BREAKER AND REPLACE WITH NEW. REFER TO RENO PANEL SCHEDULE FOR NEW BREAKER INFORMATION.

2. PROVIDE NEW BREAKER AS SHOWN.

ELECTRICAL LOAD SUMMARY

Williamson County Crac unit replacement

Time of Occurrence: Office

INUSE: Submittal: Chilled water heating hot water AHU

Business Closure/Event: None

Existing Building Load:

Peak Load x 125%: 228.4 KW

Existing Building Load: 228.4 KW

Loads below are for areas of work only

Existing Building Load:

A 12 month electric reading was taken of the building. Over the last twelve months a peak load of 182.7KW was consumed. Per NEC 220.87 that 12 month peak load can be used as the baseline for calculating the electrical service.

Peak 12 month load (KW): 182.7

Peak Load x 125%: 228.4

Existing Building Load: 228.4 KW

Loads below are for areas of work only

LOADS	AMPS	KW	Demand Factor	Total KW
Demanded Loads				
CRAC-1	6	5.0	100%	5.0
CRAC-2	6	5.0	100%	5.0
CRAC-3	6	5.0	100%	5.0
Subtotal:				15.0
New Loads				
CRAC-1	97.4	81.0	100%	81.0
CRAC-2 (ALT.1)	74.8	62.2	100%	62.2
CRAC-3 (ALT.2)	74.8	62.2	100%	62.2
CRAC-4 (ALT.1)	43.7	36.3	100%	36.3
ACCU-1	6	5.0	100%	5.0
ACCU-2 (ALT.1)	6.3	5.2	100%	5.2
ACCU-3 (ALT.1)	5.4	4.5	100%	4.5
ACCU-4 (ALT.1)	3.5	2.9	100%	2.9
Subtotal:				260.0

Total Connected Load (KVA): 473.5

(KW)

Total Connected Load @ 480V: 599.7

(Amps)

Building Available Load: 1280.3

(Amps)

Spare Available Load: 1280.3

(Amps)

Based on NEC 2020 and IEEE 243

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CONSULTANTS

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1807 GESSNER (437) 703.0000

FIRM REGISTRATION NUMBERS:

TYPE F-7461, TYPE S-F-1005980

PROJECT INFORMATION

CLIENT NAME

WILLIAMSON COUNTY

TX, USA

PROJECT NAME

ESOC Data Center

Cooling Upgrades

RSE PROJECT NO.

1446

PROJECT ADDRESS

911 Tracy Chambers Lane

Georgetown, TX 78626

ISSUED FOR

CONSTRUCTION

JULY 20, 2023

ELECTRICAL SCHEDULES

SHEET NUMBER

E701

MAIN SWITCHGEAR/STANDARD (RENO)
BUS RATING: 2000A
BUS RATING: 2000A
MAN: 2000A

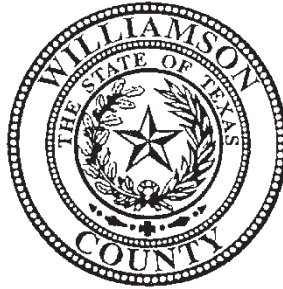
LOCATION: ELECTRICAL RM 74

TYPE/NO.	DESCRIPTION	FRAME	TRIP	R4A	R4B	R4C	TOTAL VA	AMPS	COMMENTS
N 1	EX 14		100A	5533	5533	5533	16600	20.0	
N 2	EX B11-B		40A	2213	2213	2213	6640	8.0	
N 3	EX 16		100A	5533	5533	5533	16600	20.0	
N 4	EX 15		100A	5533	5533	5533	16600	20.0	
M 5	ACCU-1 (BASE BID)		15A	1715	1715	1715	5146	6.2	
M 6	ACCU-2 (ALT. 1)		15A	1715	1715	1715	5146	6.2	
M 7	ACCU-3 (ALT. 1)		15A	1715	1715	1715	5146	6.2	
M 8	ACCU-4 (ALT. 1)		15A	1715	1715	1715	5146	6.2	
M 9	EX FCHAP-1		25A	3043	3043	3043	9130	11.0	
M 10	CRAC-1 (BASE BID)		20A	2787	2787	2787	8361	11.0	
M 11	CRAC-2 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 12	CRAC-3 (ALT. 2)		20A	2787	2787	2787	8361	11.0	
M 13	CRAC-4 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 14	CRAC-5 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 15	CRAC-6 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 16	CRAC-7 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 17	CRAC-8 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 18	CRAC-9 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 19	CRAC-10 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 20	EX CH-1		250A	6917	6917	6917	20750	25.0	
M 21	EX TP		800A	44267	44267	44267	132600	159.7	
M 22	EX LOAD		800A	44267	44267	44267	132600	159.7	
BUS TOTALS (KVA)									
DEMAND: 473.5									
DEMAND: 599.7									
BUS TOTALS (AMPS)									
DEMAND: 1280.3									
DEMAND: 1280.3									

MAIN SWITCHGEAR/STANDARD (RENO)
BUS RATING: 2000A
BUS RATING: 2000A
MAN: 2000A

LOCATION: ELECTRICAL RM 74

TYPE/NO.	DESCRIPTION	FRAME	TRIP	R4A	R4B	R4C	TOTAL VA	AMPS	COMMENTS
N 1	EX 14		100A	5533	5533	5533	16600	20.0	
N 2	EX B11-B		40A	2213	2213	2213	6640	8.0	
N 3	EX 16		100A	5533	5533	5533	16600	20.0	
N 4	EX 15		100A	5533	5533	5533	16600	20.0	
M 5	CRAC-1 (BASE BID)		15A	1715	1715	1715	5146	6.2	
M 6	CRAC-2 (ALT. 1)		15A	1715	1715	1715	5146	6.2	
M 7	CRAC-3 (ALT. 1)		15A	1715	1715	1715	5146	6.2	
M 8	CRAC-4 (ALT. 1)		15A	1715	1715	1715	5146	6.2	
M 9	EX FCHAP-1		25A	3043	3043	3043	9130	11.0	
M 10	SPARE (BASE BID)		20A	2787	2787	2787	8361	11.0	
M 11	CRAC-2 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 12	CRAC-3 (ALT. 2)		20A	2787	2787	2787	8361	11.0	
M 13	CRAC-4 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 14	CRAC-5 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 15	CRAC-6 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 16	SPARE (BASE BID)		20A	2787	2787	2787	8361	11.0	
M 17	CRAC-7 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 18	CRAC-8 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 19	CRAC-9 (ALT. 1)		20A	2787	2787	2787	8361	11.0	
M 20	EX CH-1		250A	6917	6917	6917	20750	25.0	
M 21	EX TP		800A	44267	44267	44267	132600	159.7	
M 22	EX LOAD		800A	44267	44267	44267	132600	159.7	
BUS TOTALS (KVA)									
DEMAND: 473.5									
DEMAND: 599.7									
BUS TOTALS (AMPS)									
DEMAND: 1280.3									
DEMAND: 1280.3									



UNIFORM GENERAL CONDITIONS

TABLE OF ARTICLES

1	GENERAL PROVISIONS
2	OWNER
3	CONTRACTOR
4	ARCHITECT
5	SUBCONTRACTORS
6	CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS
7	CHANGES IN THE WORK
8	TIME
9	PAYMENTS AND COMPLETION
10	PROTECTION OF PERSONS AND PROPERTY
11	INSURANCE AND BONDS
12	UNCOVERING AND CORRECTION OF WORK
13	MISCELLANEOUS PROVISIONS
14	TERMINATION OR SUSPENSION OF THE CONTRACT
15	CLAIMS AND DISPUTES

ARTICLE 1 GENERAL PROVISIONS

1.1 BASIC DEFINITIONS

1.1.1 CONTRACT DOCUMENTS

Contract Documents are enumerated in the Contract between the Owner and Contractor (hereinafter the Contract) and consist of the Contract, Conditions of the Contract as revised, Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Contract and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive or (4) a written order for a minor change in the Work issued by the Owner or the Architect. Unless specifically enumerated in the Agreement, the Contract Documents do not include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, the Contractor's bid or proposal, or portions of Addenda relating to bidding requirements.

1.1.2 CONTRACT

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Architect or the Architect's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Architect or the Architect's consultants or (4) between any persons or entities other than the Owner and the Contractor.

1.1.3 WORK

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

1.1.4 THE PROJECT

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by separate contractors.

1.1.5 THE DRAWINGS

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules and diagrams.

1.1.6 THE SPECIFICATIONS

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

1.1.7 INSTRUMENTS OF SERVICE

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

1.1.8 KNOWLEDGE

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

1.1.9 PRODUCT

Materials, systems, and equipment incorporated or to be incorporated in the Work.

1.1.10 PROVIDE

Furnish and install and shall include, without limitation, labor, materials, equipment, transportation, services, and other items required to complete the referenced tasks.

1.1.11 FURNISH

Pay for, deliver (or receive), unload, inspect, and store products, materials, equipment, and accessories as specified while retaining care, custody and control until received for installation based on a signed receipt.

1.1.12 INSTALL

Receive, unload, inspect, and store as specified while retaining care, custody and control; set or place in position, make required connections; and adjust and test as specified in the Contract Documents for satisfactory performance and operation.

1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

1.2.1

The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary,

and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the intended results. In the event of inconsistencies within or between parts of the Contract Documents, or between the Contract Documents and applicable standards, codes, and ordinances, the Contractor shall (i) provide the better quality or greater quantity of Work or (ii) comply with the more stringent requirement; either or both in accordance with the Owner or the Architect's interpretation. The terms and conditions of this **Paragraph 1.2.1**, however, shall not relieve the Contractor of any of the obligations set forth in the Contract Documents.

1.2.2

Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

1.2.3

Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

- .1** Whenever a product is specified in accordance with a Federal Specification, an ASTM Standard, an American National Standards Institute Specification, or other Association Standard, the Contractor, if required by the Specifications or if requested by the Owner, shall present evidence from the manufacture, certifying the product complies with the particular Standard or Specification. When required by the Contract Documents, supporting data shall be submitted to substantiate compliance.
- .2** Whenever a product is specified or shown by describing proprietary items, model numbers, catalog numbers, manufacturer, trade names, or similar reference, no substitutions may be made unless accepted in strict accordance with the Substitution requirements stated in the Specifications or, if no Substitution requirements are stated in the Specifications, in accordance with the requirements stated elsewhere in the Contract Documents. Where two or more products are shown or specified, the Contractor has the option to use either of those shown or specified.

1.3 CAPITALIZATION

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles or (3) the titles of other documents published by the American Institute of Architects.

1.4 INTERPRETATION

In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article

is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

1.5 USE OF DRAWINGS AND OTHER INSTRUMENTS OF SERVICE

1.5.1

The Architect and the Architect's consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and will retain all common law, statutory and other reserved rights, including copyrights, except as provided in the Owner-Architect Agreement. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with this Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

1.5.2

The Contractor, Subcontractors, Sub-subcontractors and material or equipment suppliers are authorized to use and reproduce the Instruments of Service provided to them solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers may not use the Instruments of Service on other projects or for additions to this Project outside the scope of the Work without the specific written consent of the Owner, Architect and the Architect's consultants.

1.6 TRANSMISSION OF DATA IN DIGITAL FORM

If the parties intend to transmit Instruments of Service or any other information or documentation in digital form, they shall establish the necessary protocols governing such transmissions in writing, unless otherwise already provided in the Agreement or the Contract Documents.

ARTICLE 2 OWNER

2.1 GENERAL

The Owner means Williamson County acting through any duly authorized representative as provided in the Contract, and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization ("Owner's Designated Representative"). The term "Owner" means the Owner or the Owner's authorized representative.

2.2 OWNER

2.2.1 Appropriation of Funds by Owner

Owner believes it has sufficient funds currently available and authorized for expenditure to finance the costs of the Agreement between Owner and Contractor. Contractor understands and agrees that the Owner's payment of amounts under the Agreement between Owner and Contractor is contingent on the Owner receiving appropriations or other expenditure authority sufficient to allow the Owner, in the exercise of reasonable administrative discretion, to continue to make payments under the Agreement.

2.2.2

Unless specifically stated otherwise in the Contract Documents, Contractor shall secure and pay for necessary permits, approvals, assessments, and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

2.2.3

The Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. Except for surveys or grade information, the Contractor shall compare the information furnished by the Owner, including, but not limited to, soil tests, with visibly observable physical conditions and the Contract Documents and, on the basis of such review, promptly report to the Owner and the Architect any known conflicts, errors or omissions. The Contractor shall be entitled to rely on the accuracy of information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Work.

2.2.4

The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services.

2.2.5

Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions.

2.3 OWNER'S RIGHT TO STOP THE WORK

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by **Section 12.2** or repeatedly fails to carry out Work in accordance with the Contract Documents, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity.

2.4 OWNER'S RIGHT TO CARRY OUT THE WORK

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a **ten (10)-calendar day** period after receipt of written notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such deficiencies. In such case an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Architect's additional services made necessary by such default, neglect or failure. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner.

2.5 EXTENT OF OWNER RIGHTS

2.5.1

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

2.5.2

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

2.6 OWNER'S RIGHT TO RECORDS

2.6.1

The Contractor's records, which shall include but not be limited to accounting records, written policies and procedures, subcontractor files (including proposals of successful bidders), original estimates, estimating work sheets, correspondence, schedules, change order files (including documentation covering negotiated settlements), and any other supporting evidence necessary to substantiate charges related to this contract (all foregoing hereinafter referred to as "records") and shall be open to inspection and subject to audit and/or reproduction, during normal working hours, by Owner's agent or its authorized representative to the extent necessary to adequately permit evaluation and verification of any invoices, payments or claims submitted by the Contractor or any of his payees. Such records subject to examination shall also include, but not be limited to, those records necessary to evaluate and verify direct and indirect costs (including overhead allocations) as they may apply to costs associated with this Contract.

2.6.2

For the purpose of such audits, inspections, examinations and evaluations, the Owner's agent, or authorized representatives shall have access to said records from the effective date of this Contract for the duration of Work and until **three (3) years** (or longer if required by law) after the date of final payment by Owner to Contractor.

2.6.3

Owner's agent or its authorized representative shall have access during normal business hours to the Contractor's facilities, shall have access to all necessary records and shall be provided adequate and appropriate work space, in order to conduct audits in compliance with this **Section 2.6**. Owner's agent or authorized representative shall give auditees reasonable advance notice of intended audits.

2.6.4

Contractor shall require all subcontractors, insurance agents, and material suppliers (payees) with cost plus contracts, if permitted, and not fixed price contracts to comply with the provisions of this **Article 2** by insertion of the requirements hereof in a written contract agreement between Contractor and payee. Failure to obtain such written contracts which include such provisions shall be reason to exclude some or all of the related payee's costs from amounts payable to the Contractor pursuant to this contract.

ARTICLE 3 CONTRACTOR

3.1 GENERAL

3.1.1

The Contractor is the person or entity identified as such in the Contract and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under the Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative, and if these General Conditions are used in conjunction with the Contract between Owner and Construction Manager-At-Risk, the term "Contractor" shall mean the Construction Manager.

3.1.2

The Contractor shall perform the Work in strict accordance with the Contract Documents.

3.1.3

The Contractor shall not be relieved of obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Architect in the Architect's

administration of the Contract, or by tests, inspections or approvals required or performed by persons or entities other than the Contractor.

3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

3.2.1

Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed and correlated personal observations with requirements of the Contract Documents. Prior to execution of the Contract, the Contractor and each Subcontractor shall have evaluated and satisfied themselves as to the observable conditions and limitations under which the Work is to be performed, including, without limitation, (i) the location, condition, layout, and nature of the Project site and surrounding areas, (ii) generally prevailing climatic conditions, (iii) anticipated labor supply and costs, (iv) availability and cost of materials, tools, and equipment, and (v) other similar issues. The Owner assumes no responsibility or liability for the physical condition or safety of the Project site or any improvements located on the Project site. Except as set forth in **Section 10.3**, the Contractor and its Subcontractors shall be responsible for providing a safe place for the performance of the Work. The Owner shall not be required to make any adjustment in either the Contract Sum or the Contract Time in connection with any failure by the Contractor or any Subcontractor to have complied with the requirements of **this Section 3.2**.

3.2.2

Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to **Paragraph 2.2.3**, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Owner and Architect any errors, inconsistencies or omissions discovered by or made known to the Contractor as a request for information. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that reasonably may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result will be provided whether or not specifically called for, at no additional cost to Owner. The Contractor shall verify the accuracy of elevations, dimensions, locations, and field measurements. In all cases of the interconnection of its Work with existing or other Work, the Contractor shall verify at the site all dimensions relating to such existing or other Work.

- .1 All of Contractor's and Subcontractors' work shall conform to the Contract Documents. Contractor shall be responsible for the details of the Work necessary to carry out the intent of the drawings and specifications, or which are customarily performed. When more detailed information is required for performance of the Work or when an interpretation of the Contract Documents is requested, the Contractor shall submit a written request for information to the Architect or Owner (as required), and the Owner or Architect shall furnish such information or interpretation. Where only part of the Work is indicated, similar parts shall be considered repetitive. Where any detail is shown and components thereof are fully described, similar details not fully described shall be considered to incorporate the fully described details and components.
- .2 The Contractor has had an opportunity to examine, and has carefully examined, all of the Contract Documents and Project site, and has fully acquainted itself with the scope of work, design, availability of materials, existing facilities, access, general topography, soil structure, subsurface conditions, obstructions, and all other conditions pertaining to the Work, the site of the Work, and its surrounding; that it has made necessary investigations to a full understanding of the difficulties which may be encountered in performing the Work; and that anything in any Contract Documents, or in any representations, statements, or information made or furnished by Owner or its representatives notwithstanding, Contractor will complete the Work for the compensation stated in the Contract. In addition thereto, Contractor represents that it is fully qualified to do the Work in accordance with the terms of the Contract in the time specified.

3.2.3

The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Owner and the Architect any nonconformity discovered by or made known to the Contractor as a request for information.

3.2.4

If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to **Paragraphs 3.2.2 or 3.2.3** above, the Contractor shall make Claims as provided in **Article 15**.

3.3 SUPERVISION AND CONSTRUCTION PROCEDURES

3.3.1

The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. Subcontractors are responsible for directing their forces on their portions of the Work. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract, unless the Contract Documents give other specific instructions concerning these matters. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences or procedures, the Contractor and Subcontractors shall evaluate the jobsite safety thereof and, except as stated below, shall be fully and solely responsible for the jobsite safety of such means, methods, techniques, sequences or procedures. If the Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely written notice to the Owner and Architect and shall not proceed with that portion of the Work without further written instructions from the Architect. If the Contractor is then instructed to proceed with the required means, methods, techniques, sequences or procedures without acceptance of changes proposed by the Contractor, the Owner shall be solely responsible for any loss or damage arising solely from those Owner-required means, methods, techniques, sequences or procedures.

3.3.2

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

3.3.3

The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

3.3.4

Inspection of the progress, quantity, or quality of the Work done by the Owner, any Owner's representative, any governmental agency, or the Architect, or any inspector, shall not relieve the Contractor of any responsibility for the compliance of the Work with the Contract Documents. The Owner or its approved representative (heretofore referred to as Owner's representative) shall have access to the worksite and all Work. No supervision or inspection by the Owner's representative, nor the authority to act nor any other actions taken by the Owner's representative shall relieve the Contractor of any of its obligations under the Contract Documents nor give rise to any duty on the part of the Owner.

3.4 LABOR AND MATERIALS

3.4.1

Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

- .1 Duty to Pay Prevailing Wage Rates. The Contractor shall pay not less than the wage scale of the various classes of labor as shown on the "Prevailing Wage Schedule", as defined in Paragraph 3.4.1.2 below. The specified wage rates are minimum rates only and are not representations that qualified labor adequate to perform the Work is available locally at the prevailing wage rates. The Owner is not bound to pay—and will not consider—any claims for additional compensation made by any Contractor because the Contractor pays wages in excess of the applicable minimum rate contained in the Contract Documents. The "Prevailing Wage Schedule" is not a representation that quantities of qualified labor adequate to perform the Work may be found locally at the specified wage rates.
 - a) For classifications not shown, workers shall not be paid less than the wage indicated for Laborers. The Contractor shall notify each worker commencing work on the Project of the worker's job classification and the established minimum wage rate required to be paid, as well as the actual amount being paid. The notice must be delivered to and signed in acknowledgement of receipt by the employee and must list both the monetary wages and fringe benefits to be paid or furnished for each classification in which the worker is assigned duties. When requested by Owner, competent evidence of compliance with the Texas Prevailing Wage Law shall be furnished by Contractor.
 - b) A copy of each worker wage rate notification shall be submitted to the Owner with the Application for Payment for the period during which the worker began on-site activities.
- .2 Prevailing Wage Schedule. Pursuant to Texas Government Code Section 2258.022(2), the general prevailing rate of per diem wages for each craft or type of worker needed to execute the Contract and the prevailing rate for legal holiday and overtime work shall be the most recent prevailing wage rate for Williamson County, Texas for building construction as determined by the United States Department of Labor in accordance with the Davis-Bacon Act (40 U.S.C. Section 276a et seq.), and its subsequent amendments, which are published and can be obtained online at <https://sam.gov/search/?index=dbra> (the "Prevailing Wage Schedule"). Should the

Contractor at any time become aware that a particular skill or trade not reflected on the Prevailing Wage Schedule will be or is being employed in the Work, whether by the Contractor or by a subcontractor, the Contractor shall promptly inform the Owner and shall specify a wage rate for that skill or trade, which shall bind the Contractor.

- .3 **Penalty for Violation.** The Contractor and any Subcontractor shall pay to the Owner a penalty of sixty dollars (\$60.00) for each worker employed for each calendar day, or portion thereof, that the worker is paid less than the wage rates stipulated in the Prevailing Wage Schedule or any supplement or update thereto pursuant to Paragraph 3.4.1.2 above. The Contractor and each Subcontractor shall keep, or cause to be kept, an accurate record showing the names and occupations of all workers employed in connection with the Work and showing the actual per diem wages paid to each worker, which records shall be open at all reasonable hours for the inspection by the Owner.
- .4 **Complaints of Violations of Prevailing Wage Rates.** Within thirty-one (31) days of receipt of information concerning a violation of Texas Government Code, Chapter 2258, the Owner shall make an initial determination as to whether good cause exists to believe a violation occurred. The Owner's decision on the initial determination shall be reduced to writing and sent to the Contractor or Subcontractor against whom the violation was alleged, and to the affected worker. When a good cause finding is made, the Owner shall retain the full amounts claimed by the claimant or claimants as the difference between wages paid and wages due under the Prevailing Wage Schedule and any supplements thereto, together with the applicable penalties, such amounts being subtracted from successive progress payments pending a final decision on the violation.
- .5 **Arbitration Required if Violation not Resolved.** After the Owner makes its initial determination, the affected Contractor or Subcontractor and worker have fourteen (14) days in which to resolve the issue of whether a violation occurred, including the amount that should be retained by Owner or paid to the affected worker. If the Contractor or Subcontractor and affected worker reach an agreement concerning the worker's claim, the Contractor shall promptly notify the Owner in a written document signed by the worker. If the Contractor or Subcontractor and affected worker do not agree before the fifteenth (15th) day after the Owner's determination, the Contractor or Subcontractor and affected worker must participate in binding arbitration in accordance with the Texas General Arbitration Act, Chapter 171, Tex. Civ. Prac. & Rem. Code. The parties to the arbitration have ten (10) days after the expiration of the fifteen (15) days referred to above, to agree on an arbitrator; if by the eleventh (11th) day there is no agreement to an arbitrator, a district court shall appoint an arbitrator on the petition of any of the parties to the arbitration.

- .6 Arbitration Award. If an arbitrator determines that a violation has occurred, the arbitrator shall assess and award against the Contractor or Subcontractor the amount of penalty as provided in this Section 3.4 and the amount owed the worker. The Owner may use any amounts retained hereunder to pay the worker the amount as designated in the arbitration award. If the Owner has not retained enough from the Contractor or Subcontractor to pay the worker in accordance with the arbitration award, the worker has a right of action against the Contractor and Subcontractor as appropriate, and the surety of either to receive the amount owed, attorneys' fees and court costs. The Contractor shall promptly furnish a copy of the arbitration award to the Owner.
- .7 Prevailing Wage Retainage. Money retained pursuant to this Section 3.4 shall be used to pay the claimant or claimants the difference between the amount the worker received in wages for labor on the Project at the rate paid by the Contractor or Subcontractor and the amount the worker would have received at the general prevailing wage rate as provided by the agreement of the claimant and the Contractor or Subcontractor affected, or in the arbitrator's award. The full statutory penalty of sixty dollars (\$60.00) per day of violation per worker shall be retained by the Owner to offset its administrative costs, pursuant to Texas Government Code, §2258.023. Any retained funds in excess of these amounts shall be paid to the Contractor on the earlier of the next progress payment or final payment. Provided, however, that the Owner shall have no duty to release any funds to either the claimant or the Contractor until it has received the notices of agreement or the arbitration award as provided under Paragraphs 3.4.2 and 3.4.3.
- .8 No Extension of Time. If the Owner determines that good cause exists to believe a violation has occurred, the Contractor shall not be entitled to an extension of time for any delay arising directly or indirectly from of the procedures set forth in this Section 3.4.

3.4.2

Except in the case of minor changes in the Work authorized by the Owner or Architect in accordance with **Paragraphs 3.12.8 or Section 7.4**, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with a Change Order or Construction Change Directive. If the Contractor desires to submit an alternate product or method in lieu of what has been specified or shown in the Contract Documents, the Contractor shall comply with the Substitution requirements listed in the Specifications, or if there are no Substitution requirements listed in the Specifications, then the following provisions apply:

- .1 The Contractor must submit to the Architect and the Owner (1) a full explanation of the proposed substitution and submittal of all supporting data, including technical information, catalog cuts, warranties, test results, installation instructions, operating

procedures, and other like information necessary for a complete evaluation of the substitution; (2) the adjustment, if any, in the Contract Sum, in the event the substitution is acceptable; (3) the adjustment, if any, in the time of completion of the Contract and the construction schedule in the event the substitution is acceptable; and (4) a statement indicating Contractor accepts the warranty and correction obligations in connection with the proposed substitution as if originally specified by the Architect. Proposals for substitutions shall be to the Architect in sufficient time to allow the Architect no less than **ten (10) working days** for review. No substitutions will be considered or allowed without the Contractor's submittal of complete substantiating data and information as stated hereinbefore.

3.4.3

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

3.4.4

The Contractor shall only employ or use labor in connection with the Work capable of working harmoniously with all trades, crafts, and any other individuals associated with the Project.

3.4.5.

In case the progress of the Work is affected by any undue delay in furnishing or installing any items or materials or equipment required under the Contract Documents because of such conflict involving any such labor agreement or regulation, the Owner may require that other material or equipment of equal kind and quality be provided pursuant to a Change Order or Construction Change Directive.

3.5 WARRANTY

3.5.1

The Contractor warrants to the Owner: (1) that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise; (2) that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit; (3) that the Work will be done strictly in accordance with the Contract Documents; (4) that all products are installed per the manufacturer's instructions, and in such a way that the manufacturer's warranties are preserved, including the use of a manufacturer-certified installer, if required by the manufacturer; (5) and that the Work, when finally completed, will provide a complete Project that meets the intent of the Contract Documents.

The Contractor represents and warrants to the Owner that its materials and workmanship, including without limitation, construction means, methods, procedures and techniques necessary to perform the Work, use of materials, selection of equipment and requirements of product manufacturers are and shall be consistent with: (1) good and sound practices within the construction industry; (2) generally prevailing and accepted industry standards applicable to the Work; (3) requirements of any warranties applicable to the Work subject to **Paragraph 3.2.3**. Work, materials, or equipment not conforming to these requirements shall be considered defective, and promptly after written notification of non-conformance shall be repaired or replaced by Contractor with Work conforming to this warranty. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Owner or Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

- .1 Contractor further warrants that all materials or equipment of a category or classification will be a product of the same manufacturer and such materials or equipment shall be of the same lot, batch or type and that such materials and equipment will be as specified.

3.5.2

The Contractor agrees to assign to the Owner at the time of final completion of the Work any and all manufacturer's warranties relating to materials and labor used in the Work and further agrees to perform the Work in such manner so as to preserve any and all such manufacturer's warranties.

3.6 TAXES

State Sales and Use Taxes. Sales, use or similar taxes imposed by a governmental authority that are related to the Work and for which the Contractor is liable; provided, however, Owner is a body corporate and politic under the laws of the State of Texas and claims exemption from sales and use taxes under Texas Tax Code Ann. 151.309, as amended, and the services and materials subject of the Contract are being secured for use by Owner. Exemption certificates will be provided to Contractor upon request. As a precondition to the Owner reimbursing Contractor for allowable sales and use taxes, Contractor must, on its own, first attempt to use such tax exemption certificates in order to assert the exemption. In the event Contractor's efforts to use the tax exemption certificate is unsuccessful and provided that under the laws of the State of Texas an exemption from sales and use taxes is allowed. Owner will reimburse Contractor for such sales and use taxes upon Contractor providing sufficient and satisfactory documentation to the Williamson County Auditor.

3.7 PERMITS, FEES, NOTICES, AND COMPLIANCE WITH LAWS

3.7.1

Unless otherwise provided, the Contractor shall secure, pay for, and, as soon as practicable, furnish the Owner with copies or certificates of all permits and fees, licenses, and inspections necessary for the proper execution and completion of the Work, including, without limitation, all building permits. All connection charges, assessments, or inspection fees as may be imposed by any municipal agency or utility company are included in the Contract Sum and shall be the Contractor's responsibility.

3.7.2

The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

3.7.3

If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction and damages resulting therefrom.

3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature, that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect before conditions are disturbed and in no event later than **twenty-one (21) calendar days** after first observance of the conditions. The Owner will promptly investigate such conditions and, if the Owner determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will authorize an equitable adjustment in the Contract Sum or Contract Time, or both. If the Owner determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Owner shall promptly notify the Contractor in writing, stating the reasons. If the Contractor disputes the Owner's determination, the Contractor party may assert a Claim as provided in **Article 15**.

3.7.5

If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall

promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in **Article 15**.

3.8 ALLOWANCES

3.8.1

The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

3.8.2

Unless otherwise provided in the Contract Documents,

- .1** allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- .2** Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and
- .3** whenever costs are more than or less than allowances, the Contractor shall, prior to purchasing any such materials, notify the Owner in writing of the cost and whether such cost will exceed the amount of the allowance. If Owner authorizes Contractor to proceed, after receiving the Contractor's estimate of the total cost, then the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under **Paragraph 3.8.2.1** and (2) changes in Contractor's costs under **Paragraph 3.8.2.2**.

3.9 SUPERINTENDENT

3.9.1

The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent or Contractor's project manager shall be as binding as if given to the Contractor. Important oral communications shall be immediately confirmed in writing.

3.9.2

The Contractor, as soon as practicable after award of the Contract, shall furnish in writing to the Owner through the Architect the name and qualifications of a proposed superintendent. The Owner or Architect may reply within **fourteen (14) calendar days** to the Contractor in writing stating (1) whether the Owner or the Architect has reasonable objection to the proposed superintendent or (2) that the Owner and Architect require additional time to review. Failure of the Owner or Architect to reply within the **fourteen (14)-calendar day** period shall constitute notice of no reasonable objection.

3.9.3

The Contractor shall not employ a proposed superintendent to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not unreasonably be withheld or delayed.

3.10 CONTRACTOR'S CONSTRUCTION SCHEDULES

3.10.1

The Contractor, as provided in the Contract, shall prepare and submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall not exceed time limits current under the Contract Documents, shall be revised at appropriate intervals as required by the conditions of the Work and Project, shall be related to the entire Project to the extent required by the Contract Documents, and shall provide for expeditious and practicable execution of the Work.

3.10.2

The Contractor shall prepare a submittal schedule, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, and shall submit the schedule(s) for the Architect's approval. The Architect's approval shall not unreasonably be delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Architect reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

3.10.3

The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect.

3.10.4

The construction schedule shall be a detailed precedence-style critical path management ("CPM") schedule in a format satisfactory to the Owner that shall (1) provide a graphic representation of all activities and events that will occur during performance of the Work; (2)

identify each phase of construction and occupancy; and (3) set forth dates that are critical in ensuring the timely and orderly completion of the Work in accordance with the requirements of the Contract Documents (hereinafter referred to as the "Milestone Date"). Upon review and acceptance by the Owner of the Milestone Dates, the construction schedule shall be deemed part of the Contract Documents. If not accepted, the construction schedule shall be promptly revised by the Contractor in accordance with the recommendations of the Owner and resubmitted for acceptance. The Contractor shall monitor the progress of the Work for conformance with the requirements of the construction schedule and shall promptly advise the Owner of any delays or potential delays. The accepted construction schedule shall be updated to reflect actual conditions as set forth in **Paragraph 3.10.1** or if requested by the Owner. In the event any progress report indicates any delays, the Contractor shall propose an affirmative plan to correct the delay, including overtime and/or additional labor, if necessary. In no event shall any progress report constitute an adjustment in the Contract Time, any Milestone date, or the Contract Sum unless any such adjustment is agreed to by the Owner and authorize pursuant to a Change Order.

3.10.5

In the event the Owner determines that the performance of the Work, as of a Milestone Date, has not progressed or reach the level of completion required by the Contract Documents, the Owner shall have the right to order the Contractor to take corrective measures necessary to expedite the progress of construction, including without limitation, (1) working additional shifts or overtime, (2) supplying additional manpower, equipment, and facilities, and (3) other similar measures. Such measures so continue until the progress of the Work complies with the stage of completion required by the Contract Documents. The Owner's right to require such measures is solely for the purpose of ensuring the Contractors compliance with the construction schedule.

3.11 DOCUMENTS AT THE SITE

The Contractor shall maintain at the site for the Owner one copy of the Drawings, Specifications, Addenda, Change Orders and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and one copy of approved Shop Drawings, Product Data, Samples and similar required submittals. These shall be available to the Architect and shall be delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

3.12 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

3.12.1

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

3.12.2

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

3.12.3

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

3.12.4

Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents. Their purpose is to demonstrate the way by which the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Architect is subject to the limitations of **Paragraph 4.2.7**. Informational submittals upon which the Architect is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Architect without action.

3.12.5

The Contractor shall review for compliance with the Contract Documents, approve and submit to the Architect Shop Drawings, Product Data, Samples and similar submittals required by the Contract Documents in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of separate contractors.

3.12.6

By submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

3.12.7

The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals until the respective submittal has been approved by the Architect.

3.12.8

The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents

by the Architect's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Architect in writing of such deviation at the time of submittal and (1) the Architect has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals by the Architect's approval thereof.

3.12.9

The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples or similar submittals, to revisions other than those requested by the Architect on previous submittals. In the absence of such written notice, the Architect's approval of a resubmission shall not apply to such revisions.

3.12.10

The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. The Contractor shall not be required to provide professional services in violation of applicable law. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will specify all performance and design criteria that such services must satisfy. The Contractor shall cause such services or certifications to be provided by a properly licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Architect. The Owner and the Architect shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor all performance and design criteria that such services must satisfy. Pursuant to this **Paragraph 3.12.10**, the Architect will review, approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Contractor shall not be responsible for the adequacy of the performance and design criteria specified in the Contract Documents.

3.13 USE OF SITE

The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities and

the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

3.14 CUTTING AND PATCHING

3.14.1

The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly as required by the Contract Documents. All areas requiring cutting, fitting, and patching shall be restored to the condition existing prior to the cutting, fitting and patching, unless otherwise required by the Contract Documents.

3.14.2

The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate contractor the Contractor's consent to cutting or otherwise altering the Work.

3.15 CLEANING UP

3.15.1

The Contractor shall keep the premises and surrounding area free from accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus materials from and about the Project.

3.15.2

If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and Owner shall be entitled to reimbursement from the Contractor.

3.16 ACCESS TO WORK

The Owner and Architect shall, at all times, have access to the Work in preparation and progress wherever located.

3.17 ROYALTIES, PATENTS AND COPYRIGHTS

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Architect harmless from loss on account thereof, but shall not be responsible for such defense or loss when a particular design, process or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications or other documents prepared by the Owner or

Architect. However, if the Contractor has reason to believe that the required design, process or product is an infringement of a copyright or a patent, the Contractor shall be responsible for such loss unless such information is promptly furnished to the Architect.

3.18 INDEMNIFICATION

3.18.1 INDEMNITY

OTHER THAN EMPLOYEE PERSONAL INJURY CLAIMS. TO THE FULLEST EXTENT PERMITTED BY LAW, CONTRACTOR SHALL INDEMNIFY, DEFEND, AND HOLD HARMLESS OWNER, ITS EMPLOYEES, AND ASSIGNS (THE "INDEMNIFIED PARTIES" OR "INDEMNITEES") FROM AND AGAINST CLAIMS, DAMAGES, LOSSES AND EXPENSES, INCLUDING BUT NOT LIMITED TO ATTORNEYS' FEES, ARISING OUT OF OR ALLEGED TO BE RESULTING FROM THE PERFORMANCE OF THIS CONTRACT, TO THE EXTENT CAUSED BY THE NEGLIGENT OR WILLFUL ACTS OR OMISSIONS OF THE CONTRACTOR, SUBCONTRACTORS, SUB-SUBCONTRACTORS, OR ANYONE DIRECTLY OR INDIRECTLY EMPLOYED BY THEM OR ANYONE FOR WHOSE ACTS THEY MAY BE LIABLE. CONTRACTOR SHALL NOT BE REQUIRED TO INDEMNIFY, HOLD HARMLESS OR DEFEND THE INDEMNIFIED PARTIES AGAINST A CLAIM CAUSED BY THE NEGLIGENCE OR FAULT, OR THE BREACH OR VIOLATION OF A STATUTE, ORDINANCE, GOVERNMENTAL REGULATION, STANDARD, OR RULE OF THE INDEMNITEE, OR OTHER PARTY OTHER THAN CONTRACTOR OR ITS AGENT, EMPLOYEE, OR SUBCONTRACTOR OF ANY TIER, EXCEPT THAT CONTRACTOR SHALL INDEMNIFY, HOLD HARMLESS AND DEFEND THE INDEMNIFIED PARTIES AGAINST ANY CLAIMS FOR THE BODILY INJURY OR DEATH OF AN EMPLOYEE OF CONTRACTOR, ITS AGENTS, OR ITS SUBCONTRACTORS OF ANY TIER.

3.18.2 INDEMNITY – EMPLOYEE PERSONAL INJURY CLAIMS

TO THE FULLEST EXTENT PERMITTED BY LAW, CONTRACTOR SHALL INDEMNIFY, DEFEND, AND HOLD HARMLESS THE INDEMNIFIED PARTIES AND SHALL ASSUME ENTIRE RESPONSIBILITY AND LIABILITY (OTHER THAN AS A RESULT OF AN INDEMNIFIED PARTY'S GROSS NEGLIGENCE) FOR ANY CLAIM OR ACTION BASED ON OR ARISING OUT OF THE PERSONAL INJURY, INCLUDING THE DEATH, OF ANY EMPLOYEE OF THE CONTRACTOR, SUBCONTRACTORS, OR ANY SUB-SUBCONTRACTOR, OR OF ANY OTHER ENTITY FOR WHOSE ACTS THEY MAY BE LIABLE, WHICH OCCURRED OR WAS ALLEGED TO HAVE OCCURRED ON THE PROJECT SITE OR IN CONNECTION WITH THE PERFORMANCE OF THE WORK OF THIS CONTRACT. CONTRACTOR HEREBY INDEMNIFIES THE INDEMNIFIED PARTIES EVEN TO THE EXTENT THAT SUCH PERSONAL INJURY WAS CAUSED OR ALLEGED TO HAVE BEEN CAUSED BY THE COMPARATIVE OR CONCURRENT NEGLIGENCE OF THE STRICT LIABILITY OF ANY INDEMNIFIED PARTY. THIS INDEMNIFICATION SHALL NOT BE LIMITED TO DAMAGES, COMPENSATION, OR BENEFITS PAYABLE UNDER INSURANCE POLICIES, WORKERS COMPENSATION ACTS, DISABILITY BENEFITS ACTS, OR OTHER EMPLOYEES BENEFIT ACTS.

3.18.3

THE CONTRACTOR'S INDEMNITY OBLIGATIONS UNDER THIS **SECTION 3.18** SHALL ALSO SPECIFICALLY INCLUDE, WITHOUT LIMITATION, ALL FINES, PENALTIES, DAMAGES, LIABILITY, COSTS, EXPENSES (INCLUDING, WITHOUT LIMITATION, REASONABLE ATTORNEYS' FEES) ARISING OUT OF, OR IN CONNECTION WITH, ANY (1) VIOLATION OF OR FAILURE TO COMPLY WITH ANY LAW, STATUTE, ORDINANCE, RULE, REGULATION, CODE OR REQUIREMENT OF A PUBLIC AUTHORITY THAT BEARS UPON THE PERFORMANCE OF THE WORK BY THE CONTRACTOR, A SUBCONTRACTOR, OR ANY PERSON OR ENTITY FOR WHOM EITHER IS RESPONSIBLE, (2) MEANS, METHODS, PROCEDURES, TECHNIQUES, OR SEQUENCES OF EXECUTION OR PERFORMANCE OF THE WORK, AND (3) FAILURE TO SECURE AND PAY FOR PERMITS, FEES, APPROVALS, LICENSES, AND INSPECTIONS AS REQUIRED UNDER THE CONTRACT DOCUMENTS, OR ANY VIOLATION OF ANY PERMIT OR OTHER APPROVAL OF A PUBLIC AUTHORITY APPLICABLE TO THE WORK, BY THE CONTRACTOR, A SUBCONTRACTOR, OR ANY PERSON OR ENTITY FOR WHOM EITHER IS RESPONSIBLE.

ARTICLE 4 ARCHITECT

4.1 GENERAL

4.1.1

The Owner shall retain an architect lawfully licensed to practice architecture or an entity lawfully practicing architecture in the jurisdiction where the Project is located. That person or entity is identified as the Architect in the Contract and is referred to throughout the Contract Documents as if singular in number.

4.1.2

Duties, responsibilities, and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified, or extended without written consent of the Owner, Contractor and Architect. Consent shall not be unreasonably withheld.

4.1.3

In the event that Owner has not engaged an architect and an architect is not identified in the Contract, but, rather, engages an engineer for the Project, all references made in these General Conditions to the "Architect" shall mean and include the engineer identified as the "Engineer" in the Contract and all duties, responsibilities and limitations of authority of the Architect, as set forth in the Contract Documents, shall apply to the Engineer.

4.2 ADMINISTRATION OF THE CONTRACT

4.2.1

The Architect will provide administration of the Contract as described in the Owner-Architect Agreement. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

4.2.2

The Architect will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect will not have control over, charge of, or responsibility for, the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents, except as provided in **Paragraph 3.3.1**.

4.2.3

On the basis of the site visits, the Architect will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and report to the Owner (1) known deviations from the Contract Documents and from the most recent construction schedule submitted by the Contractor, and (2) defects and deficiencies observed in the Work. The Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of and will not be responsible for acts or omissions of the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

4.2.4 COMMUNICATIONS AND CONTRACT ADMINISTRATION

Except as otherwise provided in the Contract Documents or when direct communications have been specially authorized, the Owner and Contractor shall endeavor to relate relevant communications between Owner and Architect to the Architect. Communications by and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and material suppliers shall be through the Contractor. Communications by and with separate contractors shall be through the Owner.

4.2.5

If included in Architect's scope of work, the agreement between Owner and Architect, or if requested by the Owner, the Architect will review and certify the amounts due the Contractor

and will issue Certificates for Payment in such amounts based on the Architect's evaluations of the Contractor's Applications for Payment.

4.2.6

To the extent permitted by the agreement between Owner and Architect, the Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect, in consultation with the Owner, will have authority to require inspection or testing of the Work in accordance with **Paragraphs 13.5.2 through 13.5.3**, whether or not such Work is fabricated, installed or completed. However, neither this authority of the Architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect or the Owner to the Contractor, Subcontractors, material and equipment suppliers, their agents or employees, or other persons or entities performing portions of the Work.

4.2.7

To the extent provided in the agreement between Owner and Architect, the Architect will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Owner and Architect or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Architect's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under **Sections 3.3, 3.5, and 3.12**. The Architect's review shall not constitute approval of safety precautions or, unless otherwise specifically stated by the Architect, of any construction means, methods, techniques, sequences or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

4.2.8

If requested by Owner, the Architect will prepare Change Orders and Construction Change Directives with the Owner's prior written consent, but the Architect may authorize minor changes in the Work as provided in the agreement between Owner and Architect, or in **Section 7.4**. If requested by Owner, the Architect will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in **Paragraph 3.7.4**.

4.2.9

If requested by Owner, the Architect will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to **Section 9.8**; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to **Section 9.10**; and issue a final Certificate for Payment pursuant to **Section 9.10**.

4.2.10

If the Owner and Architect agree, the Architect will provide one or more project representatives to assist in carrying out the Architect's responsibilities at the site. The duties, responsibilities, and limitations of authority of such project representatives shall be as set forth in an exhibit to be incorporated in the Contract Documents.

4.2.11

If requested by Owner, the Architect will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

4.2.12

Interpretations and decisions of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings.

4.2.13

The Architect's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents, and if approved by Owner.

4.2.14

The Architect will review and respond to requests for information about the Contract Documents. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

5.1 DEFINITIONS

5.1.1

A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a separate contractor or subcontractors of a separate contractor.

5.1.2

A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

5.2 AWARD OF SUBCONTRACTS

5.2.1 FOR CONSTRUCTION MANAGER AT-RISK CONTRACTS

The Construction Manager shall publicly advertise for bids or proposals and receive bids or proposals from trade contractors or Subcontractors for the performance of all major elements of the work other than the minor work that may be included in the general conditions. The Construction Manager may seek to perform portions of the work itself if:

- .1** the Construction Manager submits its bid or proposal for those portions of the Work in the same manner as all other trade contractors or Subcontractors; and
- .2** the Owner determines that the Construction Manager's bid or proposal provides the best value for the Owner.
- .3 Review of Bids or Proposals.** Construction Manager shall review all trade contractor or Subcontractor bids or proposals in a manner that does not disclose the contents of the bid or proposal during the selection process to a person not employed by the Construction Manager, Architect, Engineer, or Owner. All bids or proposals shall be made available to the Owner on request and to the public after the later of the award of the Contract or the **seventh (7th) business day** after the date of final selection of bids or proposals. If the Construction Manager reviews, evaluates, and recommends to the Owner a bid or proposal from a trade contractor or subcontractor but the Owner requires another bid or proposal to be accepted, the Owner shall compensate the Construction Manager by a change in the Contract Sum, Contract Time, or Cost of the

Work for any additional cost and risk that the Construction manager incurs because of the Owner's requirement that another bid or proposal be accepted.

5.2.2

The Contractor shall not contract with a proposed Subcontractor, person, or entity to whom the Owner has made reasonable objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made a reasonable objection.

5.2.3

If the Owner has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner has no reasonable objection. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, the Contract Sum and Contract Time may be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor's Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

5.2.4

The Contractor shall not substitute a Subcontractor, person, or entity previously selected if the Owner makes reasonable objection to such substitution.

5.3 SUBCONTRACTUAL RELATIONS

5.3.1

By appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work, which the Contractor, by these Documents, assumes toward the Owner. Each subcontract agreement shall preserve and protect the rights of the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

5.3.2

All subcontracts shall be in writing and, if requested, Contractor shall provide Owner with copies of executed subcontracts.

5.4 CONTINGENT ASSIGNMENT OF SUBCONTRACTS

5.4.1

The Contract is for Owner's benefit, its successors and assigns who, as well as Contractor, may directly enforce all rights and warranties, express or implied herein, but Subcontractors shall have recourse only against Contractor and not against Owner. Owner may rely solely upon Contractor for enforcement of all Subcontracts. To effect such purpose, Contractor assigns to Owner all right to bring any actions against subcontractors and material vendors without waiver by Owner of his right against Contractor because of defaults, delays and effects for which a subcontractor or material vendor may also be liable, said assignment being effective only if:

- .1 Contractor is in default under the Contract Documents; or
- .2 Owner has terminated the Contract in accordance with the Contract Documents; and
- .3 Only for those subcontract agreements which the Owner accepts by notifying the Subcontractor and Contractor in writing; and
- .4 The assignment is subject to the prior rights of the surety, if any, obligated under any bond relating to the Contract.

5.4.2

Upon such assignment, if the Work has been suspended for more than **thirty (30) calendar days**, the Subcontractor's compensation may be equitably adjusted for increases in cost resulting from the suspension.

5.4.3

Upon such assignment to the Owner under this **Section 5.4**, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

5.4.4

The Architect and the Owner shall have the right to request from any Subcontractor at any time during the course of construction, a notarized affidavit stating the amount of monies which have been paid to the Subcontractor as of any certain stipulated date.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

6.1 OWNER'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS

6.1.1

The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and to award separate contracts in connection with other portions of the Project or other construction or operations on the site under Conditions of the Contract identical or substantially similar to these including those portions related to insurance and waiver of subrogation. If the Contractor claims that delay or additional cost is involved because of such action by the Owner, the Contractor shall make such Claim as provided in **Article 15**.

6.1.2

When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Contract.

6.1.3

The Contractor shall participate with other separate contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to the construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, separate contractors and the Owner until subsequently revised.

6.2 MUTUAL RESPONSIBILITY

6.2.1

The Contractor shall afford the Owner and separate contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

6.2.2

If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a separate contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly report to the Architect and the Owner apparent discrepancies or defects in such other construction that would render it unsuitable for such proper execution and results. Failure of the Contractor so to report shall constitute an acknowledgment that the Owner's or separate contractor's completed or partially completed

construction is fit and proper to receive the Contractor's Work, except as to defects not then reasonably discoverable.

6.2.3

The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a separate contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a separate contractor's delays, improperly timed activities, damage to the Work or defective construction.

6.2.4

The Contractor shall promptly remedy damage the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or separate contractors as provided in **Paragraph 10.2.5**.

6.2.5

The Owner and each separate contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in **Section 3.14**.

6.2.6

All separate contractors shall sign a site access agreement with Contractor setting forth duties, responsibilities, safety, and administrative requirements.

6.3 OWNER'S RIGHT TO CLEAN UP

If a dispute arises among the Contractor, separate contractors and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and allocate the cost among those responsible.

ARTICLE 7 CHANGES IN THE WORK

7.1 GENERAL

7.1.1

Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this **Article 7** and elsewhere in the Contract Documents.

7.1.2

A Change Order shall be based upon agreement among the Owner, Contractor and Architect; a Construction Change Directive requires agreement by the Owner and Architect and may or

may not be agreed to by the Contractor; an order for a minor change in the Work may be issued by the Owner or Architect alone.

7.1.3

Changes in the Work shall be performed under applicable provisions of the Contract Documents, and the Contractor shall proceed promptly, unless otherwise provided in the Change Order, Construction Change Directive, or order for a minor change in the Work. Except as permitted in **Section 7.3** and **Paragraph 9.7.2**, a change in the Contract Sum or the Contract Time shall be accomplished only by Change Order. Accordingly, no course of conduct or dealings between the parties, nor express or implied acceptance of alterations or additions to the Work, and no claim that Owner has been unjustly enriched by any alteration of or addition to the Work, whether or not there is, in fact, any unjust enrichment to the Work, shall be the basis of any Claim to an increase in any amounts due under the Contract Documents or a change in any time period provided for in the Contract Documents.

7.2 CHANGE ORDERS

7.2.1

A Change Order is a written instrument signed by the Owner, Contractor and Architect stating their agreement upon all of the following:

- .1** The change in the Work;
- .2** The amount of the adjustment, if any, in the Contract Sum; and
- .3** The extent of the adjustment, if any, in the Contract Time.

7.2.2

Contractor's Change Order shall set forth in clear and precise detail breakdowns of labor and materials for all trades involved and the estimated impact on the dates of Substantial Completion. Contractor shall furnish supporting data as reasonably requested by Owner.

7.2.3

Agreement on any Change Order shall constitute a final settlement of all matters relating to the change in the Work that is the subject of the Change Order, including, but not limited to, all direct and indirect costs associated with such change and any and all adjustments to the Contract Sum and the construction schedule.

7.3 CONSTRUCTION CHANGE DIRECTIVES

7.3.1

A Construction Change Directive is a written order signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum

or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

7.3.2

A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

7.3.3

If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

- .1** Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
- .2** Unit prices stated in the Contract Documents or subsequently agreed upon;
- .3** Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
- .4** As provided in **Paragraph 7.3.7**.

7.3.4

If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed in a proposed Change Order or Construction Change Directive so that application of such unit prices to quantities of Work proposed will cause substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

7.3.5

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

7.3.6

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

7.3.7

If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Owner shall determine the method and the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Contract, or if no such amount is set forth in the Contract, a reasonable amount. In such case, and also under **Paragraph 7.3.3.3**, the Contractor shall keep and present, in such form as the Owner or Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this **Paragraph 7.3.7** shall be limited to the following:

- .1** Costs of labor, including social security, old age and unemployment insurance, fringe benefits required by agreement or custom, and workers' compensation insurance;
- .2** Costs of materials, supplies and equipment, including cost of transportation, whether incorporated or consumed;
- .3** Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;
- .4** Costs of premiums for all bonds and insurance, permit fees, and sales, use or similar taxes related to the Work; and
- .5** Additional costs of supervision and field office personnel directly attributable to the change.

7.3.8

The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Owner or the Architect. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

7.3.9

Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The Owner will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Owner determines to be reasonably justified. The Owner's interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of Contractor to disagree and assert a Claim in accordance with **Article 15**.

7.3.10

When the Owner and Contractor agree with a determination made concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Architect will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

7.4 MINOR CHANGES IN THE WORK

If permitted in the agreement between Owner and Architect, the Architect has authority to order minor changes in the Work not involving adjustment in the Contract Sum or extension of the Contract Time and not inconsistent with the intent of the Contract Documents.

ARTICLE 8 TIME

8.1 CONTRACT TIME

TIME IS AN ESSENTIAL ELEMENT OF THE CONTRACT. The Contract Time is the time between the dates indicated in the Notice to Proceed for commencement of the Work and for achieving Substantial Completion. The Contract Time can be modified only by Change Order. Failure to achieve Substantial Completion within the Contract Time, as otherwise agreed to in writing, will cause damage to Owner and may subject Contractor to liquidated damages as provided in the Contract. If Contractor fails to achieve Final Completion within **thirty (30) calendar days** after Substantial Completion or a mutually agreed upon longer period of time between Contractor and Owner, Contractor shall be responsible for Owner's additional inspection, project management, and maintenance cost to the extent caused by Contractor's failure to achieve Final Completion.

8.2 NOTICE TO PROCEED

Owner will issue a Notice to Proceed which shall state the dates for beginning the Work and for achieving Substantial Completion of the Work.

8.3 WORK PROGRESS SCHEDULE

Unless indicated otherwise, Contractor shall submit to Owner and Architect the initial Work Progress Schedule for the Work in relation to the entire Project not later than **twenty-one (21) calendar days** after the effective date of the Notice to Proceed. Unless indicated otherwise, the Work Progress Schedule shall be computerized Critical Path Method (CPM) with fully editable logic. This initial schedule shall indicate the dates for starting and completing the various aspects required to complete the Work, including mobilization, procurement, installation, testing, inspection, delivery of Close-out Documents, and acceptance of all the

Work of the Contract. When acceptable to Owner, the initially accepted schedule shall be the Baseline Schedule for comparison to actual conditions throughout the Contract duration.

8.3.1 SCHEDULE REQUIREMENTS

Contractor shall submit electronic and paper copy of the initial Work Progress Schedule reflecting accurate and reliable representations of the planned progress of the Work, the Work to date if any, and of Contractor's actual plans for its completion. Contractor shall organize and provide adequate detail, so the schedule is capable of measuring and forecasting the effect of delaying events on completed and uncompleted activities.

- .1 Contractor shall resubmit initial schedule as required to address review comments from Architect and Owner until such schedule is accepted as the Baseline Schedule.
- .2 Submittal of a schedule, schedule revision or schedule update constitutes Contractor's representation to Owner of the accurate depiction of all progress to date and that Contractor will follow the schedule as submitted in performing the Work.

8.3.2 SCHEDULE UPDATES

Contractor shall update the Work Progress Schedule and the Submittal Register monthly, as a minimum, to reflect progress to date and current plans for completing the Work, while maintaining original schedule as Baseline Schedule and submit electronic copies of the update to Owner and Architect as directed, but as a minimum with each request for payment. Owner has no duty to make progress payments unless accompanied by the updated Work Progress Schedule. Show the anticipated date of completion reflecting all extensions of time granted through Change Order as of the date of the update. Contractor may revise the Work Progress Schedule when in Contractor's judgment it becomes necessary for the management of the Work. Contractor shall identify all proposed changes to schedule logic to Owner and to Architect via an executive summary accompanying the updated schedule for review prior to final implementation of revisions into a revised Baseline Schedule. Schedule changes that materially impact Owner's operations shall be communicated promptly to Owner and Architect and shall not be incorporated into the revised Baseline Schedule without Owner's consent.

8.3.3

The Work Progress Schedule is for Contractor's use in managing the Work and submittal of the schedule, and successive updates or revisions, is for the information of Owner and to demonstrate that Contractor has complied with requirements for planning the Work. Owner's acceptance of a schedule, schedule update, or revision constitutes Owner's agreement to coordinate its own activities with Contractor's activities as shown on the schedule.

- .1 Acceptance of the Work Progress Schedule, or update and/or revision thereto does not indicate any approval of Contractor's proposed sequences and duration.

- .2 Acceptance of a Work Progress Schedule update or revision indicating early or late completion does not constitute Owner's consent, alter the terms of the Contract, or waive either Contractor's responsibility for timely completion or Owner's right to damages for Contractor's failure to do so.
- .3 Scheduled dates for completion of any activity or the entire Work do not constitute a change in terms of the Contract. Change Orders are the only method of modifying the Substantial Completion Date(s) and Contract Time.

8.4 COMPLETION OF WORK

Contractor is accountable for completing the Work within the Contract Time stated in the Contract, or as otherwise amended by Change Order.

8.4.1

If, in the judgment of Owner, the work is behind schedule and the rate of placement of Work is inadequate to regain scheduled progress to ensure timely completion of the entire Work or a separable portion thereof, Contractor, when so informed by Owner, shall immediately take action to increase the rate of work placement by:

- .1 An increase in working forces.
- .2 An increase in equipment or tools.
- .3 An increase in hours of work or number of shifts.
- .4 Expedite delivery of materials.
- .5 Other action proposed, if acceptable to Owner.

8.4.2

Within **ten (10) calendar days** after such notice from Owner, Contractor shall notify Owner in writing of the specific measures taken or planned to increase the rate of progress. Contractor shall include an estimate as to the date of scheduled progress recovery and an updated Work Progress Schedule illustrating Contractor's plan for achieving timely completion of the Project. Should Owner deem the plan of action inadequate, Contractor shall take additional steps or make adjustments, as necessary, to its plan of action until it meets with Owner's approval.

8.5 MODIFICATION OF CONTRACT TIME

8.5.1

Delays and extension of time as hereinafter described are valid only if executed in accordance with provisions set forth in **Article 7**.

8.5.2

When a delay defined herein as excusable prevents Contractor from completing the Work within the Contract Time, Contractor is entitled to an extension of time. Owner will make an equitable adjustment and extend the number of days lost because of excusable delay or Weather Days, as measured by Contractor's progress schedule. All extensions of time will be granted in calendar days. In no event, however, will an extension of time be granted for delays that merely extend the duration of non-critical activities without delaying the project Substantial Completion date(s).

- .1 A "Weather Day" is a day on which Contractor's current schedule indicates Work is to be done, and on which inclement weather or related site conditions prevent Contractor from performing **seven (7) continuous hours** of Work on the critical path between the hours of 7:00 a.m. and 6:00 p.m.
 - A. Weather days are excusable delays and, in the event of precipitation, Contractor may claim **one (1) Weather Day** for each day of the precipitation plus an additional day for each **tenth (1/10th) of an inch** of accumulation as determined by a third-party website agreed upon by Owner and Contractor.
 - B. At the end of each calendar month, Contractor shall submit to Owner and Architect a list of Weather Days occurring in that month along with documentation of the impact on critical activities. Based on confirmation by Owner, any time extension granted will be issued by Change Order. If Contractor and Owner cannot agree on the time extension, Owner may issue a Construction Change Directive (CCD) for a fair and reasonable time extension.
- .2 **Excusable Delay.** Contractor is entitled to an equitable adjustment of the Contract Time, issued via Change Order, for delays caused by the following:
 - A. Errors, omissions, and imperfections in design, which Architect corrects by means of changes in the Drawings and Specifications.
 - B. Unanticipated physical conditions at the Site, which Architect corrects by means of changes to the Drawings and Specifications or for which Owner directs changes in the Work identified in the Contract Documents.
 - C. Failure of Owner to have secured property, right-of-way, or easements necessary for Work to begin or progress.

- D. Changes in the Work that effect activities identified in Contractor's schedule as "critical" to completion of the entire Work, if such changes are ordered by Owner or recommended by Architect and ordered by Owner.
- E. Suspension of Work for unexpected natural events, Force Majeure (sometimes called "acts of God"), civil unrest, strikes or other events which are not within the reasonable control of Contractor.
- F. Suspension of Work for convenience of Owner, which prevents Contractor from completing the Work within the Contract Time.
- G. Administrative delays caused by activities or approval requirements related to an Authority Having Jurisdiction.

8.5.3

Contractor's relief in the event of such delays is the time impact to the critical path as determined by analysis of Contractor's schedule. In the event that Contractor incurs additional direct costs because of the excusable delays other than described in **Subparagraph 8.5.2.2.D** and within the reasonable control of Owner, the Contract Sum and Contract Time are to be equitably adjusted by Owner pursuant to the provisions of **Article 7**.

8.6 NO DAMAGES FOR DELAY

Due to the unique requirements of working within a public facility which may be shared with other user-groups and adjacent to other public facilities, Owner may, at any time, restrict the Work to non-disruptive activities to reduce noise, vibration, air pollution, or any other nuisance, intrusion, or danger affecting adjacent public functions and duties. In each case, Owner will make a good faith effort to provide sufficient advanced notice of restriction to Contractor; and, Contractor shall make a good faith effort to reallocate activities, materials, and forces onsite to avoid delay to the project schedule. Contractor has no claim for monetary damages for delay or hindrances to the work from any cause, including without limitation any act or omission of Owner.

8.7 CONCURRENT DELAY

When the completion of the Work is simultaneously delayed by an excusable delay and a delay arising from a cause not designated as excusable, Contractor may be entitled to a reasonable time extension for the period of concurrent delay, as may be agreed to in writing between Contractor and Owner.

8.8 OTHER TIME EXTENSION REQUESTS

Time extensions requested in association with changes to the Work directed or requested by Owner shall be included with Contractor's proposed costs for such change. Time extensions requested for inclement weather are covered by **Paragraph 8.5.2.1** above. If Contractor believes that the completion of the Work is delayed by a circumstance other than for changes

directed to the Work or weather, they shall give Owner written notice, stating the nature of the delay and the activities potentially affected, within **five (5) calendar days** after the onset of the event or circumstance giving rise to the excusable delay. Contractor shall provide sufficient written evidence to document the delay. In the case of a continuing cause of delay, only one claim is necessary. State claims for extensions of time in numbers of whole or half days.

8.8.1

Within **ten (10) calendar days** after the cessation of the delay, Contractor shall formalize its request for extension of time in writing to include a full analysis of the schedule impact of the delay and substantiation of the excusable nature of the delay. All changes to the Contract Time or made as a result of such claims is by Change Order, as set forth in **Article 7**.

8.8.2

No extension of time releases Contractor or the Surety furnishing a performance or payment bond from any obligations under the Contract or such a bond. Those obligations remain in full force until the discharge of the Contract.

8.8.3 CONTENTS OF TIME EXTENSION REQUESTS

Contractor shall provide with each Time Extension Request a quantitative demonstration of the impact of the delay on project completion time, based on the Work Progress Schedule. Contractor shall include with Time Extension Requests a reasonably detailed narrative setting forth:

- .1** The nature of the delay and its cause; the basis of Contractor's claim of entitlement to a time extension.
- .2** Documentation of the actual impacts of the claimed delay on the critical path indicated in Contractor's Work Progress Schedule, and any concurrent delays.
- .3** Description and documentation of steps taken by Contractor to mitigate the effect of the claimed delay, including, when appropriate, the modification of the Work Progress Schedule.

8.8.4 OWNER'S RESPONSE

Owner will respond to the Time Extension Request by providing to Contractor written notice of the number of days granted, if any, and giving its reason if this number differs from the number of days requested by Contractor.

- .1** Owner will not grant time extensions for delays that do not affect the Contract Substantial Completion date.

- .2 Owner will respond to each properly submitted Time Extension Request within **fifteen (15) calendar days** following receipt. If Owner cannot reasonably make a determination about Contractor's entitlement to a time extension within that time, Owner will notify Contractor in writing. Unless otherwise agreed by Contractor, Owner has no more than **fifteen (15) additional calendar days** to prepare a final response. If Owner fails to respond within **forty-five (45) calendar days** from the date the Time Extension Request is received, Contractor is entitled to a time extension in the amount requested.

8.9 FAILURE TO COMPLETE WORK WITHIN THE CONTRACT TIME

TIME IS AN ESSENTIAL ELEMENT OF THE CONTRACT. Contractor's failure to substantially complete the Work within the Contract Time or to achieve Substantial Completion as required will cause damage to Owner. These damages shall be liquidated by agreement of Contractor and Owner, in the amount per day as set forth in the Contract.

8.10 LIQUIDATED DAMAGES

Owner may collect liquidated damages due from Contractor directly or indirectly by reducing the Contract Sum in the amount of liquidated damages stated in the Contract.

ARTICLE 9 PAYMENTS AND COMPLETION

9.1 CONTRACT SUM

The Contract Sum is stated in the Contract and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

9.2 SCHEDULE OF VALUES

Where the Contract is based on a stipulated sum or Guaranteed Maximum Price ("GMP"), the Contractor shall submit to the Owner and Architect, before the first Application for Payment, a schedule of values allocating the entire Contract Sum to the various portions of the Work and prepared in such form and supported by such data to substantiate its accuracy as the Owner may require. This schedule, unless objected to by the Owner, shall be used as a basis for reviewing the Contractor's Applications for Payment.

9.3 APPLICATIONS FOR PAYMENT

9.3.1

As provided in the Contract and in the Contract Documents, the Contractor shall submit to the Owner and Architect an itemized Application for Payment prepared in accordance with the schedule of values, if required under **Section 9.2.**, for completed portions of the Work. Such application shall be notarized, if required, and supported by such data substantiating the Contractor's right to payment as the Owner or Architect may require, such as copies of

requisitions from Subcontractors and material suppliers, and shall reflect retainage if provided for in the Contract Documents.

- .1 As provided in **Paragraph 7.3.9**, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Owner or the Architect, but not yet included in Change Orders.
- .2 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or material supplier, unless such Work has been performed by others whom the Contractor intends to pay.
- .3 If requested by Owner or required elsewhere in the Contract Documents, Each Application for Payment shall be accompanied by the following, all in a form and substance satisfactory to the Owner:
 - a) With each Application for Payment: a current Sworn Statement from the Contractor setting forth all Subcontractors and all material suppliers with whom the Contractor has subcontracted, the amount of each such subcontract, the amount requested for any Subcontractor or material supplier in the Application for Payment, and the amount to be paid to the Contractor from such progress payment;
 - b) With each Application for Payment: a duly executed Conditional Waiver and Release on Progress Payment from the Contractor and Subcontractors establishing receipt of payment or satisfaction of the payment requested by the Contractor in the current Application for Payment;
 - c) Commencing with the second Application for Payment submitted by the Contractor, a duly executed Unconditional Waiver and Release on Progress Payment from Contractor and all Subcontractors, material suppliers and, where appropriate, lower tier subcontractors that have billed more than **five thousand dollars (\$5,000)** on a single application of payment, establishing receipt of payment or satisfaction of payment of all amounts requested on behalf of such entities and disbursed prior to submittal by the Contractor of the current Application for Payment;
 - d) With the Final Application for Payment: Contractor shall submit a Conditional Waiver and Release on Final Payment as required by **Texas Property Code, §53.284**. Upon receipt of final payment, Contractor shall submit an Unconditional Waiver and Release on Final Payment as required by **Texas Property Code, §53.284**; and

- e) Such other information, documentation, and materials as the Owner, or the title insurer may require in order to ensure that Owner's property is free of lien claims. Such other documents may include, without limitation, original copies of lien or bond claim releases suitable for filing with the County Clerk in Williamson County, Texas.

9.3.2

Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage and transportation to the site for such materials and equipment stored off the site.

9.3.3

The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information and belief, be free and clear of liens, bond claims, claims, security interests or encumbrances in favor of the Contractor, Subcontractors, material suppliers, or other persons or entities making a claim by reason of having provided labor, materials and equipment relating to the Work.

- .1 The Contractor further expressly undertakes to defend Owner, at the Contractor's sole expense, against any actions, lawsuits, or proceedings brought against Owner as a result of liens filed against the Work, the site of any of the Work, the Project site and any improvements thereon, or any portion of the property of any of Owner (referred to collectively as "liens" in this **Paragraph 9.3.3**), provide the Owner has paid Contractor pursuant to the requirements of the Contract Documents. The Contractor hereby agrees to indemnify and hold Owner harmless against any such liens or claims of lien and agrees to pay any judgment or lien resulting from any such actions, lawsuits, or proceedings.
- .2 The Owner shall release any payments withheld due to a lien or bond claims if the Contractor obtains security acceptable to the Owner, however, the Contractor shall not be relieved of any responsibilities or obligations under this **Paragraph 9.3.3**, including, without limitation, the duty to defend and indemnify Owner.

- .3 Retainage.** The Owner shall withhold from each progress payment, as retainage, **five percent (5%)** of the total earned amount. Retainage so withheld shall be managed in conformance with **Texas Government Code, Chapter 2252, Subchapter B**. Any request for reduction or release of retainage shall be accompanied by written consent of the Contractor's Surety. No such request shall be made until the Contractor has earned at least **sixty-five percent (65%)** of the total Contract Sum.
- .4** For purposes of **Texas Government Code, §2251.021 (a)(2)**, the date the performance of service is completed is the date when the Owner's representative approves the Application for Payment.

9.4 CERTIFICATES FOR PAYMENT

9.4.1

The Architect will, within **seven (7) business days** after receipt of the Contractor's Application for Payment, either issue to the Owner a Certificate for Payment, with a copy to the Contractor, for such amount as the Architect determines is properly due, or notify the Contractor and Owner in writing of the Architect's reasons for withholding certification in whole or in part as provided in **Paragraph 9.5.1**.

9.4.2

The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data comprising the Application for Payment, that, to the best of the Architect's knowledge, information and belief, the Work has progressed to the point indicated and that the quality of the Work is in accordance with the Contract Documents. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion and to specific qualifications expressed by the Architect. The issuance of a Certificate for Payment will further constitute a representation that the Contractor is entitled to payment in the amount certified. However, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work, (2) reviewed construction means, methods, techniques, sequences or procedures, (3) reviewed copies of requisitions received from Subcontractors and material suppliers and other data requested by the Owner to substantiate the Contractor's right to payment, or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

9.5 DECISIONS TO WITHHOLD CERTIFICATION

9.5.1

The Owner or Architect may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Owner or Architect's opinion the representations to the Owner required by **Paragraph 9.4.2** cannot be made. If the Owner or Architect is unable to certify payment in the amount of the Application, the Owner or Architect will notify the Contractor. If the Contractor and Architect, or Contractor and Owner, as the case may be, cannot agree on a revised amount, the Architect will promptly issue a Certificate for Payment for the amount that can be certified. The Owner or Architect may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Owner or Architect's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in **Paragraph 3.3.2**, because of

- .1 defective Work not remedied;
- .2 third party claims filed or reasonable evidence indicating probable filing of such claims;
- .3 failure of the Contractor to make payments properly to Subcontractors or for labor, materials or equipment;
- .4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- .5 damage to the Owner or a separate contractor;
- .6 failure to maintain the scheduled progress, or reasonable evidence that the Work will not be completed within the Contract Time;
- .7 failure to comply with the requirements of **Texas Government Code, Chapter 2258** (Prevailing Wage Law);
- .8 failure to include sufficient documentation to support the amount of payment requested for the Project;
- .9 failure to obtain, maintain, or renew insurance coverage, payment/performance bonds or warranty bond required by the Contract Documents; or
- .10 repeated failure to carry out the Work in accordance with the Contract Documents.

9.5.2

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

9.6 PROGRESS PAYMENTS

9.6.1

The Owner shall make payment in the manner and within the time provided in the Contract Documents and in accordance with **Texas Government Code, Chapter 2251**.

9.6.2

The Contractor shall pay each Subcontractor no later than **ten (10) calendar days** after receipt of payment from the Owner the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

9.6.3

The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and material and equipment suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within **seven (7) calendar days**, the Owner shall have the right to contact Subcontractors to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay or to see to the payment of money to a Subcontractor, except as may otherwise be required by law.

9.6.4

Contractor payments to material and equipment suppliers shall be treated in a manner similar to that provided in **Paragraph 9.6.2**.

9.6.5

A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

9.7 FAILURE OF PAYMENT

9.7.1

If the Architect is required to issue Certificates for Payment and, through no fault of the Contractor, the Architect fails to timely issue Certificates for Payment in the time permitted in the Contract Documents, or if the Owner does not pay the Contractor by the date established in the Contract Documents, then the Contractor may, upon **twenty-one (21)**

business days written notice to the Owner and Architect, stop the Work until payment of the amount owing has been received.

9.7.2

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

9.8 SUBSTANTIAL COMPLETION

9.8.1

Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use; provided, however, that as a condition precedent to Substantial Completion, the Owner has received all certificates of occupancy and any other permits, approvals, licenses, and other documents from any governmental authority having jurisdiction thereof necessary for the beneficial occupancy of the Project.

9.8.2

When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Owner and Architect a comprehensive list of items to be completed or corrected prior to final payment (punch list). Failure to include an item on the punch list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

9.8.3

Upon receipt of the Contractor's punch list, the Owner and Architect will examine the Work to determine whether the Work or designated portion thereof is substantially complete. If the Owner and/or Architect's examination discloses any item, whether or not included on the Contractor's punch list, that is not sufficiently complete in accordance with the Contract Documents, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Owner or Architect. In such case, the Contractor shall then submit a request for another examination by the Owner or Architect to determine Substantial Completion.

9.8.4

When the Work or designated portion thereof is substantially complete, the Architect, if required by the Contract Documents, or Owner will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion, shall establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance, and shall fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Unless otherwise provided, Contractor shall complete all items on the punch list within **thirty (30) calendar days** of Substantial Completion. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

9.8.5

The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in such Certificate. Upon such acceptance and consent of surety, if any, the Owner shall make payment of retainage.

9.9 PARTIAL OCCUPANCY OR USE

9.9.1

The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer as required under **Paragraph 11.3.1.5**, the surety, and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Architect as provided under **Paragraph 9.8.2**. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld.

9.9.2

Immediately prior to partial occupancy or use, the Owner, Contractor and Architect shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

9.9.3

Partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

9.10 FINAL COMPLETION AND FINAL PAYMENT

9.10.1

Upon receipt of the Contractor's written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Owner and Architect will make such inspection and, when the Owner and Architect find the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance with terms and conditions of the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in **Paragraph 9.10.2** as precedent to the Contractor's being entitled to final payment have been fulfilled. All warranties and guarantees required under or pursuant to the Contract Documents shall be assembled and delivered by the Contractor to the Architect as part of the final Application for Payment. The final Certificate for Payment will not be issued by the Architect until all warranties and guarantees have been received and accepted by the Owner.

9.10.2

Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Owner and Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work have been paid or otherwise satisfied, within the period of time required by **Texas Government Code, Chapter 2251**, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect and will not be canceled or allowed to expire until at least **thirty (30) business days** prior written notice has been given to the Owner, (3) a written statement that the Contractor knows of no substantial reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety to final payment, (5) a warranty bond in a form acceptable to Owner, and (6) other data establishing payment or satisfaction of obligations, such as receipts, unconditional full and final releases and waivers of liens, claims, security interests or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner.

9.10.3

The making of final payment shall constitute a waiver of Claims by the Owner except those arising from

- .1 Claims, security interests or encumbrances arising out of the Contract and unsettled;
- .2 failure of the Work to comply with the requirements of the Contract Documents; or
- .3 terms of warranties required by the Contract Documents.

9.10.4

Acceptance of final payment by the Contractor, a Subcontractor or material supplier shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

10.1 SAFETY PRECAUTIONS AND PROGRAMS

The Contractor and its Subcontractors shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Contract.

10.2 SAFETY OF PERSONS AND PROPERTY**10.2.1**

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

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

10.2.2

The Contractor and its Subcontractors shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury, or loss. Notwithstanding any language to the contrary, the Owner shall not have any responsibility for job site inspections or safety recommendations. Any inspections or observations by the Owner or the Architect are solely for the benefit of the Owner and shall not create any duties or obligations to anyone else.

10.2.3

The Contractor and its Subcontractors shall erect and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection,

including posting danger signs and other warnings against hazards, promulgating safety regulations and notifying owners and users of adjacent sites and utilities.

10.2.4

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

10.2.5

The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in **Paragraphs 10.2.1.2 and 10.2.1.3** caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under **Paragraphs 10.2.1.2 and 10.2.1.3**, except damage or loss attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under **Section 3.18**.

10.2.6

The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Architect.

10.2.7

The Contractor and its Subcontractors shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

10.2.8 Injury or Damage to Person or Property

If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, written notice of such injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding **twenty-one (21) calendar days** after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter.

10.2.9

When all or a portion of the Work is suspended for any reason, the Contractor shall securely fasten down all covering and fully protect the Work, as necessary, from injury or damage by any cause.

10.2.10

The Contractor shall promptly report 8.7 to the Owner and Architect all accidents arising out of or in connection with the Work that cause death, personal injury, or property damage.

10.3 HAZARDOUS MATERIALS

10.3.1

The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and report the condition to the Owner and Architect in writing.

10.3.2

Upon receipt of the Contractor's written notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written notice from the Owner.

10.3.3

The Owner shall not be responsible under this **Section 10.3** for materials or substances the Contractor brings to the site unless such materials or substances are expressly required by the Contract Documents. The Owner shall be responsible for materials or substances expressly required by the Contract Documents, except to the extent of the Contractor's fault or negligence in the use and handling of such materials or substances.

10.3.4

The Contractor shall indemnify the Owner for the cost and expense the Owner incurs (1) for remediation of a material or substance the Contractor brings to the site or negligently handles, or (2) where the Contractor fails to perform its obligations under **Paragraph 10.3.1**, except to the extent that the cost and expense are due to the Owner's fault or negligence.

10.4 EMERGENCIES

In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury, or loss. Additional compensation or extension of time, if any, claimed by the Contractor on account of an emergency shall be determined as provided in **Article 7** and **Article 15**.

ARTICLE 11 INSURANCE AND BONDS

11.1 CONTRACTOR'S LIABILITY INSURANCE

11.1.1

The Contractor shall purchase from and maintain in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located such insurance as will protect the Contractor from claims set forth below which may arise out of or result from the Contractor's operations and completed operations under the Contract and for which the Contractor may be legally liable, whether such operations be by the Contractor or by a Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

- .1** Claims under workers' compensation, disability benefit and other similar employee benefit acts that are applicable to the Work to be performed;
- .2** Claims for damages because of bodily injury, occupational sickness or disease, or death of the Contractor's employees;
- .3** Claims for damages because of bodily injury, sickness or disease, or death of any person other than the Contractor's employees;
- .4** Claims for damages insured by usual personal injury liability coverage;
- .5** Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom;
- .6** Claims for damages because of bodily injury, death of a person or property damage arising out of ownership, maintenance or use of a motor vehicle;
- .7** Claims for bodily injury or property damage arising out of completed operations, which coverage shall be maintained for no less than **four (4) years** following final payment; and
- .8** Claims involving contractual liability insurance applicable to the Contractor's obligations under **Section 3.18**.

11.1.2

The insurance required by **Paragraph 11.1.1** shall be written for not less than limits of liability specified in the Contract or the Contract Documents. Coverages, whether written on an occurrence or claims-made basis, shall be maintained without interruption from the date of

commencement of the Work until the date of final payment and termination of any coverage required to be maintained after final payment, and, with respect to the Contractor's completed operations coverage, until the expiration of the period for correction of Work or for such other period for maintenance of completed operations coverage as specified in the Contract Documents.

11.1.3

Unless otherwise provided, copies of the insurance policies, in form acceptable to the Owner, shall be provided to Owner within **thirty (30) calendar days** of Owner's request. Except as otherwise provided, all of the policies provided shall name Owner as an additional insured, and such policies shall immediately deliver to Owner copies of all such insurance policies, together with certificates by the insurer evidencing Owner's coverage there under. Each policy of insurance obtained by Contractor pursuant to the Contract Documents shall provide, by endorsement or otherwise (1) that such policy shall not be canceled, endorsed, altered or reissued to effect a change in coverage for any reason or to any extent whatsoever unless the insurer shall have first given Owner and Lender at least **thirty (30) calendar days** prior written notice thereof, and (2) that Owner may, but shall not be obligated to, make premium payments to prevent the cancellation, endorsement, alteration or reissuance of such policy and such payments shall be accepted by the insurer to prevent the same. Such policies shall provide, by endorsement or otherwise, that Contractor shall be solely responsible for the payment of all premiums under the policies, and that Owner shall have no obligation for the payment thereof, notwithstanding that Owner is named as additional insured under the policy. Any insured loss or claim of loss shall be adjusted to the Owner, and any settlement payments shall be made payable to the Owner as a trustee for the insureds, as their interests may appear. Upon the occurrence of an insured loss or claim of loss, monies received will be held by Owner who shall make distribution in accordance with an agreement to be reached in such event between Owner and Contractor. If the parties are unable to agree between themselves on the settlement of the loss, such dispute shall be resolved in accordance with **Article 15**, below, but the Work of the Project shall nevertheless progress during any such period of dispute without prejudice to the rights of any party to the dispute. The Contractor shall be responsible for any loss within the deductible area of the policy. If Owner is damaged by the failure of Contractor to purchase or maintain such insurance, then Contractor shall bear all costs properly attributable thereto. The Contractor shall affect and maintain similar property insurance on portions of the Work stored off the site or in transit when such portions of the Work are to be included. Such property insurance shall be maintained, unless otherwise provided in the Contract Documents or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until Final Completion of the Project.

11.1.4

The Contractor shall cause the commercial liability coverage required by the Contract Documents to include (1) the Owner as additional insureds for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's operations; and

(2) the Owner as an additional insured for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's completed operations.

11.2 OWNER'S LIABILITY INSURANCE

The Owner shall be responsible for purchasing and maintaining the Owner's usual liability insurance.

11.3 PROPERTY INSURANCE

11.3.1

Unless otherwise provided in the Contract Documents, the Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located, property insurance written on a builder's risk "all-risk" or equivalent policy form in the amount of the initial Contract Sum, plus value of subsequent Contract Modifications and cost of materials supplied or installed by others, comprising total value for the entire Project at the site on a replacement cost basis without optional deductibles. Such property insurance shall be maintained, unless otherwise provided in the Contract Documents or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until final payment has been made as provided in **Section 9.10** or until no person or entity other than the Owner has an insurable interest in the property required by this **Section 11.3** to be covered, whichever is later. This insurance shall include interests of the Owner, the Contractor, Subcontractors and Sub-subcontractors in the Project.

- .1** Property insurance shall be on an "all-risk" or equivalent policy form and shall include, without limitation, insurance against the perils of fire (with extended coverage) and physical loss or damage including, without duplication of coverage, theft, vandalism, malicious mischief, collapse, earthquake, flood, windstorm, falsework, testing and startup, temporary buildings and debris removal including demolition occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for Architect's and Contractor's services and expenses required as a result of such insured loss as well as coverage for building materials while in transit or building materials suitably stored at a temporary location. Property insurance provided by the Contractor shall not cover any tools, apparatus, machinery, scaffolding, hoists, forms, staging, shoring, and other similar items commonly referred to as construction equipment that may be on the site and the capital value of which is not included in the Work. The Contractor shall make its own arrangements for any insurance it may require on such construction equipment. Any such policy obtained by the Contractor under this **Paragraph 11.3.1** shall include a waiver of subrogation in accordance with the requirements of **Paragraph 11.3.4**.
- .2** If the Contractor does not intend to purchase such property insurance required by the Contract and with all of the coverages in the amount described above, the Contractor shall so inform the Owner in writing prior to commencement of the Work. If the

Owner is damaged by the failure or neglect of the Contractor to purchase or maintain insurance as described above, without so notifying the Owner in writing, then the Contractor shall bear all reasonable costs properly attributable thereto.

- .3 Contractor shall be responsible for any deductibles to the extent that the loss arose out of or was caused by Contractor's negligence or breach of the Contract.
- .4 This property insurance shall cover portions of the Work stored off the site, and also portions of the Work in transit.
- .5 Partial occupancy or use in accordance with **Section 9.9** shall not commence until the insurance company or companies providing property insurance have consented to such partial occupancy or use by endorsement or otherwise. The Owner and the Contractor shall take reasonable steps to obtain consent of the insurance company or companies and shall, without mutual written consent, take no action with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.

11.3.2 WAIVERS OF SUBROGATION

The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents and employees, each of the other, and (2) the Architect, Architect's consultants, separate contractors described in **Article 6**, if any, and any of their subcontractors, sub-subcontractors, agents and employees, for damages caused by fire or other causes of loss to the extent of actual recovery of any insurance proceeds under any property insurance obtained pursuant to this **Section 11.3** or other property insurance applicable to the Work, except such rights as they have to proceeds of such insurance. However, this waiver shall not apply to property insurance purchased by Owner after completion of the Work or Final Payment, whichever comes first. The Owner or Contractor, as appropriate, shall require of the Architect, Architect's consultants, separate contractors described in **Article 6**, if any, and the subcontractors, sub-subcontractors, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged.

11.3.3

A loss insured under the property insurance shall be adjusted in good faith and made payable to the Owner in good faith for the insureds, as their interests may appear. The Contractor shall pay Subcontractors their just shares of insurance proceeds received by the Contractor,

and by appropriate agreements, written where legally required for validity, shall require Subcontractors to make payments to their Sub-subcontractors in similar manner.

11.4 BONDS

11.4.1

The Contractor is required to tender to Owner, prior to commencing the Work, performance and payment bonds, as required by law. In the event Contractor fails to provide such bonds within the time provided by the Contract, Owner may immediately, upon notice of such failure, or within a reasonable time thereafter, at its sole option and discretion: (1) void this Contract in its entirety; or (2) procure such bonds on behalf of the Contractor, deducting such amounts from the Contract Sum. In the event Owner voids the Contract under this **Section 11.4**, Contractor may forfeit its bid bond.

11.4.2

A Performance Bond is required if the Contract Sum is in excess of **fifty thousand dollars (\$50,000)**. The performance bond is solely for the protection of the Owner, in the full amount of the Contract Sum and conditioned on the faithful performance of the Work in accordance with the Contract Documents. The form of the bond shall be approved by the Owner.

11.4.3

A Payment Bond is required if the Contract Sum is in excess of **twenty-five thousand dollars (\$25,000)**. A payment bond is payable to the Owner, in the full amount of the Contract Sum and solely for the protection and use of payment bond beneficiaries who have a direct contractual relationship with the Contractor or a supplier of required materials or labor. The form of bond shall be approved by the Owner.

11.4.4 Warranty Bond.

Prior to final payment, Contractor shall provide Owner with a Warranty Bond in the sum of **ten percent (10%)** of the Contract Sum or **ten percent (10%)** of the GMP for Construction Manager At-Risk Contracts for **twelve (12) months** from Substantial Completion of the Work. The form of bond shall be approved by the Owner.

11.4.5

Corporate sureties authorized to issue bonds shall be qualified and comply with relevant provisions of the Texas Insurance Code.

11.4.6

Each bond shall be executed by a corporate surety or sureties authorized to do business in the State of Texas and acceptable to the Owner. If any bond is for more than **ten percent (10%)** of the surety's capital and surplus, the Owner may require certification that the company has reinsured the excess portion with one or more reinsurers authorized, accredited, or trusted to do business in the State. A reinsurer may not reinsure for more than **ten percent (10%)** of

its capital and surplus. If a surety upon a bond loses its authority to do business in the State, the Contractor shall within **thirty (30) calendar days** after such loss furnish a replacement bond at no added cost to the Owner.

11.4.7

Each bond shall be accompanied by a valid Power-of-Attorney (issued by the surety company and attached, signed and sealed with the corporate embossed seal, to the bond) authorizing the attorney in fact who signs the bond to commit the company to the terms of the bond, and stating any limit in the amount for which the attorney can issue a single bond.

11.4.8

The process of requiring and accepting bonds and making claims thereunder shall be conducted in compliance with **Texas Government Code, Chapter 2253**. If for any reason a statutory payment or performance bond is not honored by the surety, the Contractor shall fully indemnify and hold the Owner harmless of and from any costs, losses, obligations or liabilities it incurs as a result.

11.4.9

Owner shall furnish certified copies of a payment bond and the related Contract between Owner and Contractor to any qualified person seeking copies who complies with **Texas Government Code, §2253.026**.

11.4.10 Claims on Payment Bonds.

Claims on payment bonds must be sent directly to the Contractor and its surety in accordance with Texas Government Code, §2253.041. All Payment Bond claimants are cautioned that no lien exists on the funds unpaid to the Contractor on such contract, and that reliance on notices sent to the Owner may result in loss of their rights against the Contractor and/or its surety. The Owner is not responsible in any manner to a claimant for collection of unpaid bills, and accepts no such responsibility because of any representation by any agent or employee.

11.4.11 Payment Claims when Payment Bond not Required.

When the value of the Contract between Owner and the Contractor is less than twenty-five thousand dollars (\$25,000), claimants and their rights are governed by Texas Property Code, §53.231-239. These provisions set out the requirements for filing a valid lien on funds unpaid to the Contractor as of the time of filing the claim, actions necessary to release the lien and satisfaction of such claims.

11.4.12

Sureties shall be listed on the **Department of the Treasury's Listing of Approved Sureties** stating companies holding Certificates of Authority as acceptable sureties on Federal Bonds and acceptable reinsuring companies (Department Circular 570).

11.5 GENERAL REQUIREMENTS

11.5.1

Unless otherwise provided in the Contract Documents, all insurance coverage procured by the Contractor shall be provided by insurance companies having policy holder ratings no lower than "A" and financial ratings not lower than "VIII" in the Best's Insurance Guide, the latest edition in effect as of the date of the Contract, and subsequently in effect at the time of renewal of any policies required by the Contract Documents.

11.5.2

If the Owner is damaged by failure of the Contractor to purchase or maintain insurance required under this **Article 11**, then the Contractor shall bear all reasonable costs (including attorneys' fees and court and settlement expenses) properly attributable thereto.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

12.1 UNCOVERING OF WORK

12.1.1

If a portion of the Work is covered contrary to the Owner or Architect's request or to requirements specifically expressed in the Contract Documents, it must, if requested in writing by the Owner or Architect, be uncovered for examination and be replaced at the Contractor's expense without change in the Contract Time. If prior to the date of Substantial Completion the Contractor, a Subcontractor, or anyone for whom either is responsible uses or damages any portion of the Work (other than start-up), including, without limitation, mechanical, electrical, plumbing, and other building systems, machinery, equipment, or other mechanical device, the Contractor shall cause such item to be restored to "like new" condition at no expense to the Owner.

12.1.2

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

12.2 CORRECTION OF WORK

12.2.1

The Contractor shall promptly correct Work rejected by the Owner or Architect or failing to conform to the requirements of the Contract Documents, whether discovered before or after Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.

12.2.2 AFTER SUBSTANTIAL COMPLETION

- .1 In addition to the Contractor's obligations under **Section 3.5**, if, within **one (1) year** after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under **Paragraph 9.9.1**, or by terms of an applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of written notice from the Owner to do so. The Owner shall give such notice promptly after discovery of the condition. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Architect, the Owner may, without prejudice to any other remedies, correct it in accordance with **Section 2.4** or file a claim with the surety of any applicable warranty bond.
- .2 The **one (1)-year** period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

12.2.3

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

12.2.4

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

12.2.5

Nothing contained in this **Section 12.2** shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the **one (1)-year** period for correction of Work as described in **Paragraph**

12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

12.3 ACCEPTANCE OF NONCONFORMING WORK

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

ARTICLE 13 MISCELLANEOUS PROVISIONS

13.1 GOVERNING LAW

The Contract shall be governed by the law of Williamson County, Texas.

13.2 SUCCESSORS AND ASSIGNS

The Owner and Contractor respectively bind themselves, their partners, successors, assigns and legal representatives to covenants, agreements and obligations contained in the Contract Documents. Except as provided in the Contract Documents or by law, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make such an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

13.3 WRITTEN NOTICE

Written notice shall be deemed to have been duly served if delivered in person to the individual, to a member of the firm or entity, or to an officer of the corporation for which it was intended; or if delivered at, or sent by registered or certified mail or by courier service providing proof of delivery to, the last business address known to the party giving notice.

13.4 RIGHTS AND REMEDIES

13.4.1

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

13.4.2

No action or failure to act by the Owner, Architect or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act

constitute approval of or acquiescence in a breach there under, except as may be specifically agreed in writing.

13.5 TESTS AND INSPECTIONS

13.5.1

Tests, inspections and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority. The Contractor shall give the Owner and Architect timely notice of when and where tests and inspections are to be made so that the Owner and Architect may be present for such procedures. The Owner shall bear costs of tests, inspections, or approvals where building codes or applicable laws or regulations prohibit the Owner from delegating their cost to the Contractor.

13.5.2

If the Architect, Owner, or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection, or approval not included under **Paragraph 13.5.1**, the Architect will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection or approval by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Owner and Architect of when and where tests and inspections are to be made so that the Owner and Architect may be present for such procedures.

13.5.3

If such procedures for testing, inspection or approval under **Paragraphs 13.5.1 and 13.5.2** reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure including those of repeated procedures and compensation for the Architect's services and expenses shall be at the Contractor's expense. The Contractor also agrees the cost of testing services related to remedial operations performed to correct deficiencies in the Work, shall be borne by the Contractor.

13.5.4

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

13.5.5

If the Architect is to observe tests, inspections or approvals required by the Contract Documents, the Architect will do so promptly and, where practicable, at the normal place of testing.

13.5.6

Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

13.6 INTEREST

The rate of interest that accrues on an overdue payment is the rate in effect on September 1 of the fiscal year in which the payment becomes overdue. The rate in effect on September 1 is equal to the sum of:

13.6.1

one percent (1%); and

13.6.2

the prime rate as published in the Wall Street Journal on the **first (1st) day of July** of the preceding fiscal year that does not fall on a Saturday or Sunday pursuant to **Texas Government Code, §2251.025**.

13.7 TIME LIMITS ON CLAIMS

The Owner and Contractor shall commence all claims and causes of action, whether in contract, tort, breach of warranty or otherwise, against the other arising out of or related to the Contract in accordance with the time limits provided by law. Nothing herein shall be construed as shortening the period of time Owner has for commencing claims to less than what is required by law.

13.8 APPLICATION TO SUBCONTRACTS

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

13.9 GENERAL PROVISIONS

13.9.1

All personal pronouns used in the Contract, whether used in the masculine, feminine, or neuter gender, shall include all other genders; and the singular shall include the plural and vice versa. Titles of articles, sections, and paragraphs are for convenience only and neither

limit nor amplify the provisions of the Contract. The use herein of the word "including," when following any general statement, term, or matter, shall not be construed to limit such statement, term, or matter to the specific items or matters set forth immediately following such word or to similar items or matters, whether or not non-limiting language (such words as "without limitation," or "but not limited to," or words of similar import) is used with reference thereto, but rather shall be deemed to refer to all other items or matters that could reasonably fall within the broadest possible scope of such general statement, term, or matter.

13.9.2

Wherever possible, each provision of this Contract shall be interpreted in a manner as to be effective and valid under applicable law. If, however, any provision of this Contract, or portion thereof, is prohibited by law or found invalid under any law, only such provision or portion thereof shall be ineffective, without in any manner invalidating or affecting the remaining provisions of this Contract or valid portions of such provision, which are hereby deemed servable.

13.10 NO ORAL WAIVER

The Provisions of the Contract Documents shall not be changed, amended, waived, or otherwise modified in any respect except by a writing signed by Owner. No person is authorized on behalf of Owner to orally change, amend, waive, or otherwise modify the terms of the Contract Documents or any of the Contractor's duties or obligations under or arising out of the Contract Documents. Any change, waiver, approval, or consent granted to the Contractor shall be limited to the specific matters stated in the writing signed by Owner, and shall not relieve Contractor of any other of the duties and obligations under the Contract Documents. No "constructive" changes shall be allowed.

13.11 TEXAS PUBLIC INFORMATION ACT

To the extent, if any, that any provision in the Contract Documents is in conflict with Tex. Gov't Code 552.001 et seq., as amended (the "Public Information Act"), the same shall be of no force or effect. Furthermore, it is expressly understood and agreed that Owner, its officers and employees may request advice, decisions and opinions of the Attorney General of the State of Texas in regard to the application of the Public Information Act to any information or data furnished to Owner whether or not the same are available to the public. It is further understood that Owner, its officers and employees shall have the right to rely on the advice, decisions and opinions of the Attorney General, and that Owner, its officers and employees shall have no liability or obligation to Contractor for the disclosure to the public, or to any person or persons, of any software or a part thereof, or other items or data furnished to Owner by Contractor in reliance of any advice, decision or opinion of the Attorney General of the State of Texas.

13.12 EQUAL OPPORTUNITY IN EMPLOYMENT

The Contractor agrees that during the performance of the Contract it will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or

national origin. The Parties will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; termination; rates of pay or other forms of compensation, and selection for training, including apprenticeship.

13.13 SECURED FACILITIES

In the event any Work is performed in, on or around a secured facility owned or operated by Owner (*i.e.* Owner's jail, juvenile center, detention center, etc.), Contractor shall be required to obtain and provide to Owner background checks of each individual (employees and representatives of Contractor, Subcontractors and Sub-Subcontractors) who performs any Work at a secured facility prior to such individual's access to a secured facility. Owner shall have a right to refuse access to any individual who has a criminal history that would possibly jeopardize the safety and security of a secured facility.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

14.1 TERMINATION BY THE CONTRACTOR

14.1.1

The Contractor may terminate the Contract if the Work is stopped for a period of **ninety (90) consecutive days** through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons or entities performing portions of the Work under direct or indirect contract with the Contractor, for any of the following reasons:

- .1** Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;
- .2** An act of government, such as a declaration of national emergency that requires all Work to be stopped; or
- .3** Because the Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in **Paragraph 9.4.1**, or because the Owner has not made payment on an undisputed Certificate for Payment within the time stated in the Contract Documents.

14.1.2

The Contractor may terminate the Contract if, through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons or entities performing portions of the Work under direct or indirect contract with the Contractor, repeated suspensions, delays or interruptions of the entire Work by the Owner as described

in **Section 14.3** constitute in the aggregate more than **one hundred percent (100%)** of the total number of days scheduled for completion, or **one hundred twenty (120) days** in any **three hundred sixty-five (365)-day** period, whichever is less.

14.1.3

If one of the reasons described in **Paragraph 14.1.1 or 14.1.2** exists, the Contractor may, upon **thirty (30) business days** written notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, including reasonable overhead and profit, costs incurred by reason of such termination, and damages.

14.2 TERMINATION BY THE OWNER FOR CAUSE

14.2.1

The Owner may terminate the Contract if the Contractor

- .1** fails to commence the Work in accordance with the provisions of the Contract,
- .2** fails to prosecute the Work to completion thereof in a diligent, efficient, timely, workmanlike, skillful and careful manner and in strict accordance with the provisions of the Contract,
- .3** fails to use an adequate amount or quality of personnel or equipment to complete the Work without undue delay,
- .4** fails to perform any of its obligations under the Contract,
- .5** fails to make prompt payments when due to its Subcontractors and Suppliers, or as required by **Texas Government Code, Chapter 2251**,
- .6** files any petition or other pleading seeking any relief under any provisions of the Federal Bankruptcy Act, as amended, or any other federal or state statute or law providing for reorganization of debts or other relief from creditors, permits a receiver or other person to be appointed on account of its insolvency or financial condition, or becomes insolvent,
- .7** creates any situation or state of facts which would authorize or permit an involuntary petition in bankruptcy to be filed against Contractor, or
- .8** has not met or in Owner's opinion will not meet the dates of Substantial Completion set forth in the Contract Documents.

14.2.2

When any of the above reasons exist, the Owner, in its sole and absolute discretion, may without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, **thirty (30) calendar days** written notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

- .1** Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
- .2** Accept assignment of subcontracts pursuant to **Section 5.4**; and
- .3** Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

14.2.3

When the Owner terminates the Contract for one of the reasons stated in **Paragraph 14.2.1**, the Contractor shall not be entitled to receive further payment until the Work is finished. In the event that a final decision under **Article 15**, below, is rendered that sufficient cause did not exist for termination under this **Section 14.2**, then the termination shall be considered a termination for convenience, under **Section 14.4**, below.

14.2.4

If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages and costs incurred by the Owner in finishing the Work and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner.

14.3 SUSPENSION BY THE OWNER FOR CONVENIENCE

14.3.1

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

14.3.2

The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay or interruption as described in **Paragraph 14.3.1**. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

- .1** that performance is, was or would have been so suspended, delayed or interrupted by another cause for which the Contractor is responsible; or

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

14.4 TERMINATION BY THE OWNER FOR CONVENIENCE

14.4.1

The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

14.4.2

Upon receipt of written notice from the Owner of such termination for the Owner's convenience, the Contractor shall

- .1 cease operations as directed by the Owner in the notice;
- .2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and
- .3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

14.4.3

For Construction Manager At-Risk Contracts, upon such termination, the Contractor shall recover the amounts provided in **Paragraph 12.1.3** of the Contract between Owner and Construction Manager-At-Risk. For all other contracts, upon such termination, Contractor shall recover costs of the Work executed, including reasonable overhead and profit, costs incurred to and including the date of termination, will be due and payable in accordance with the Contract Documents.

ARTICLE 15 CLAIMS AND DISPUTES

15.1 CLAIMS

15.1.1 DEFINITION

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim.

15.1.2 NOTICE OF CLAIMS

Claims for events arising during the performance of the Work by Contractor must be initiated by written notice to the other party with a copy sent to the Owner; provided, however, that the claimant shall use its best efforts to furnish the other party, as expeditiously as possible, with notice of any Claim including, without limitation, those in connection with concealed or unknown conditions, once such claim is recognized, and shall take steps to mitigate the alleged or potential damages, delay, or other adverse consequences arising out of the condition that is the cause of such a Claim. Claims by Contractor must be initiated within **ten (10) business days** after occurrence of the event giving rise to such Claim or within **ten (10) business days** after the claimant first recognizes the condition giving rise to the Claim, whichever is later. Claims may also be reserved in writing within the time limits set forth in this **Paragraph 15.1.2**. Any notice of Claim or reservation of Claim must clearly identify the alleged cause and the nature of the Claim and include data and information available to the claimant that will facilitate prompt verification and evaluation of the Claim.

15.1.3 CONTINUING CONTRACT PERFORMANCE

Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in **Section 9.7** and **Article 14**, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents. The Architect will prepare Change Orders and issue Certificates for Payment in accordance with the Contract Documents.

15.1.4 CLAIMS FOR ADDITIONAL COST

If the Contractor wishes to make a Claim for an increase in the Contract Sum, written notice as provided herein shall be given before proceeding to execute the Work. Prior notice is not required for Claims relating to an emergency endangering life or property arising under **Section 10.4**.

15.1.5 CLAIMS FOR ADDITIONAL TIME

- .1** If the Contractor wishes to make a Claim for an increase in the Contract Time, written notice as provided herein shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary.
- .2** If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated and had an adverse effect on the scheduled construction.

15.2 MEDIATION

15.2.1

Claims, disputes, or other matters in controversy arising out of or related to the Contract except those waived shall be subject to mediation as a condition precedent to seeking redress in a court of competent jurisdiction.

15.2.2

The parties shall endeavor to resolve their Claims by mediation, which shall consist of a single mediator who is knowledgeable about the subject matter of the Contract. A request for mediation shall be made in writing, delivered to the other party to the Contract.

15.2.3

The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in Williamson County, Texas. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

15.2.4

All disputes not resolved through mediation shall be decided in litigation in Williamson County, Texas.

15.2.5 NO WAIVER OF IMMUNITY

Nothing in the Contract Documents shall be deemed to waive, modify or amend any legal defense available at law or in equity to Owner, its past or present officers, employees, or agents, nor to create any legal rights or claim on behalf of any third party. Owner does not waive, modify, or alter to any extent whatsoever the availability of the defense of governmental immunity under the laws of the State of Texas and of the United States.