

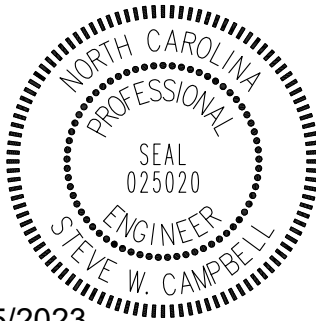


G.W. BULLUCK ELEMENTARY SCHOOL CHILLER REPLACEMENT

ROCKY MOUNT, NORTH CAROLINA

PDC Project #23013

APRIL 2023



04/25/2023



04/25/2023

Prepared by
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ADVERTISEMENT FOR BIDS

INVITATION FOR PROPOSALS

FOR

EDGECOMBE COUNTY SCHOOLS - G.W. BULLUCK ELEMENTARY SCHOOL CHILLER UPGRADE

Pursuant to Section 143-131 of the General Statutes of North Carolina, informal single prime bids are solicited and will be received in the office of Jerome Williams located at 2305 N. Main Street, Tarboro, North Carolina at any time before 2:00 PM on May 25, 2023 and then publicly opened and read at Facilities Office Conference Room.

A MANDATORY pre-bid conference will be held at the project site at G..W. Bulluck Elementary School, 3090 Bulluck School Road Rocky Mount, NC 27801 on May 8, 2023 at 11:00am.

Proposals must be enclosed in a sealed envelope addressed to Mr. Jerome Williams, Director of Maintenance, 2305 North Main Street, Tarboro, NC, 27886. The outside of the envelope must be marked "**Proposal For Edgemcombe County Schools - G.W. Bulluck ES Chiller Upgrade**" and shall indicate the name, address, telephone number and state license number of the bidder. Proposals must be submitted on the printed form, or exact copies thereof, contained in the Contract Documents.

Bid, Performance and Payment Bonds are required for this project.

All Contractors are notified that North Carolina Statutory provisions as to licensing for contractors will be observed in receiving, reading and awarding of contracts.

Plans and specifications, including Contract Documents, are open to public inspection in the office of the Director of Maintenance and are available upon request from Progressive Design Collaborative, 3101 Poplarwood Court, Suite 320, Raleigh, NC 27604, Email sgado@pdcengineers.com

The School Board/Owner reserves the right to reject any or all proposals. The bidder to whom the contract may be awarded must comply with the requirements of G.S. Section 143-131, as amended.

No bids may be withdrawn after the scheduled closing time for the receipt of proposals for a period of forty-five (45) days.

END OF SECTION 00 11 13

BID/ACCEPTANCE FORM

for

EDGECOMBE COUNTY SCHOOLS - G.W. BULLUCK ELEMENTARY SCHOOL CHILLER & PUMP UPGRADE

The project includes chiller and pump upgrade. Associated electrical

We are in receipt of

Addendum 1 _____ Addendum 2 _____ Addendum 3 _____

The undersigned, as bidder, proposes and agrees if this bid is accepted to contract with Edgecombe County Schools for the furnishing of all materials, equipment, and labor necessary to complete the construction of the work described in these documents in full and complete accordance with plans, specifications, and contract documents, and to the full and entire satisfaction of the Owner for the sum of:

BASE BID: _____ Dollars \$ _____

ALTERNATE #1 BID:(ADD / DEDUCT) _____ Dollars \$ _____

General Subcontractor

License #:

Electrical Subcontractor

License #:

Respectively submitted this _____ day of _____ 20__

(Contractor's Name)

Federal ID# _____ By: _____

Witness: _____ Title: _____

(Owner, partner, corp. Pres. Or Vice President)

Address: _____

(Proprietorship or Partnership)

Attest: (corporation)

Email Address: _____

(Corporate Seal)

By: _____ License #: _____

Title: _____

(Corporation, Secretary / Ass't Secretary)

ACCEPTED by EDGECOMBE COUNTY SCHOOLS

Total amount of accepted by the owner, included base bid and bid alternates: _____

BY: _____ TITLE: _____

FORMAL GENERAL CONDITIONS FOR FEDERALLY FUNDED PROJECTS

TABLE OF ARTICLES

1. CONTRACT DOCUMENTS
2. OWNER
3. CONTRACTOR
4. SUBCONTRACTORS
5. WORK BY OWNER OR BY SEPARATE CONTRACTORS
6. MISCELLANEOUS PROVISIONS
7. TIME
8. PAYMENTS AND COMPLETION
9. INSURANCE
10. CHANGES IN THE WORK
11. UNCOVERING AND CORRECTION
12. TERMINATION OF THE CONTRACT
13. FEDERALLY FUNDED PROJECTS

ARTICLE 1

CONTRACT DOCUMENTS

GENERAL

The Contract Documents consist of the Owner-Contractor Agreement, the Conditions of the Contract (General, Supplementary and other Conditions), the Drawings, the Specifications, and all Addenda issued prior to and all 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 issued pursuant to the provisions of Article 10, (3) a written interpretation issued by the Design Consultant, or (4) a written order for a minor change in the Work issued pursuant to this contract.

By executing the Contract, the Contractor represents that he has visited the site, familiarized himself with the local conditions under which the Work is to be performed, and correlated his observations with the requirements of the Contract Documents.

The Contractor will be furnished with zero (0) sets of drawings and specifications at no cost. Copies may be purchased.

END OF ARTICLE 1

ARTICLE 2

OWNER INFORMATION, SERVICES AND RIGHTS OF THE OWNER

The Owner shall at all times have access to the Work whenever it is in preparation or progress. The Contractor shall provide safe facilities for such access.

The Owner shall not be responsible for or have control or charge of the construction means, methods, techniques, sequences, or procedures, or for safety precautions and programs in connection with the Work, and will not be responsible for the Contractor's failure to carry out the Work in accordance with the Contract Documents.

The Owner will have authority to require special inspection or testing of the Work whether or not such Work is then fabricated, installed, or completed. However, neither the Owner's authority to act under Subparagraph 6.5.3, nor any decision made by the Owner in good faith either to exercise or not to exercise such authority shall give rise to any duty or responsibility of the Owner to the Contractor, any Subcontractor, any of their agents or employees, or any other person performing any of the Work.

The Owner shall have the authority and discretion to call, schedule, and conduct job meetings to be attended by the Contractor, representatives of his Subcontractors, and the Design Consultant, to discuss such matters as procedures, progress, problems, and scheduling.

The Owner and Design Consultant shall not be responsible or liable to Contractor for the acts, errors or omission of the Contractor, any separate Subcontractor, any separate contractor or any contractor's or subcontractor's agents or employees, or any other persons performing any of the Work.

Information or services under the Owner's control shall be furnished by the Owner with reasonable promptness to avoid unreasonable delay in the orderly progress of the Work.

The parties acknowledge that the Owner may perform all or part of its obligations pursuant to this Agreement through the Superintendent or his designee.

The foregoing rights are in addition to other rights of the Owner enumerated herein and those provided by law.

OWNER'S RIGHT TO STOP OR TO SUSPEND THE WORK

If the Contractor fails to correct defective Work or fails to carry out the Work or supply labor and materials in accordance with the Contract Documents, the Owner by a written order may order the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of the Owner to stop the Work shall not give rise to any duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity.

The Owner may order the Contractor in writing to suspend, delay, or interrupt all or any part of the Work for such period of time as he may determine to be appropriate for the convenience of the Owner.

If the performance of all or any part of the Work (including the work of the Contractor and its subcontractors) is, for an unreasonable period of time, suspended, delayed, or interrupted by an act of the Owner or the Design Consultant in the administration of this Contract, or by failure of any one of them to act within the time specified in this Contract (or if no time is specified, within a reasonable time), an adjustment shall be made for an increase in the actual time required for performance of the Work by the Contractor, due solely to such unreasonable suspension, delay, or interruption and the Contract modified in writing accordingly. However, no claim shall be made under this Subparagraph for any suspension, delay, or interruption pursuant to Subparagraph 2.3.1, or for which claim is provided or excluded under any other provision of this Contract. No claim under this Subparagraph shall be allowed on behalf of the Contractor or its subcontractors, unless within 10 days after the act or failure to act involved, and for continuing or ongoing acts or failures to act within 10 days of the first day of the act or failure to act the Contractor submits to the Owner a written statement setting forth, as fully as then practicable, the extent of such claim, and unless the claim is asserted in writing within 20 days after the termination of such suspension, delay, or interruption. For continuing or ongoing acts or failures to act, the Contractor shall update its written statement every 15 days until the suspension, delay or interruption is terminated. The Contractor shall waive any and all claims not filed in strict conformance with this paragraph. The Contractor shall indemnify, defend and hold the Owner harmless from any claim by a Subcontractor that is waived because it is not filed in strict conformance with this paragraph or any other provision of this Agreement regarding claims.

In the event of a suspension of work or delay or interruption of work, the Contractor will and will cause his subcontractors to protect carefully his, and their, materials and work against damage or injury from the weather and maintain completed and uncompleted portions of the work as required by the Contract Documents. If, in the opinion of the Owner, any work or material shall have been damaged or injured by reason of failure on the part of the Contractor or any of his subcontractors to so protect same, such work and materials shall be removed and replaced at the expense of the Contractor.

No claim by the Contractor shall be allowed if asserted after final payment under this Contract or if it is not asserted in strict conformance with Article 10.

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 ten days after the date written notice is mailed by the Owner to commence and continue remedy of such default or neglect with diligence and promptness, the Owner may, without prejudice to any other remedy he may have, make good such deficiencies and may further elect to complete all Work thereafter through such means as the Owner may select, including the use of a new contractor. In such case the Owner shall issue a Change Order deducting from the payments then or thereafter due the Contractor the cost of correcting such deficiencies, including compensation for the Design Consultant's additional services made necessary by such default, neglect or failure. Such action by the Owner and the amount charged to the Contractor are both subject to the prior approval of the Design Consultant. If the payments then or thereafter due the Contractor are not sufficient to cover such amount, the Contractor shall pay the difference to the Owner. Notwithstanding the Owner's right to carry out a portion of the work, warranty, maintenance and protection of the work remains the Contractor's responsibility. Further, the provisions of this paragraph do not affect the Owner's right to require the correction of defective or non-conforming work in accordance with this contract.

END OF ARTICLE 2

ARTICLE 3

CONTRACTOR DEFINITION

This entire Contract is not one of agency by the Contractor for Owner but one in which Contractor is engaged independently in the business of providing the services and performing the Work herein described as an independent contractor.

REVIEW OF CONTRACT DOCUMENTS

Before placing his proposal to the Owner, and continuously after execution of the Contract, the Contractor shall carefully study and compare the Contract Documents and shall at once report to the Owner any error, inconsistency or omission he may discover, including any requirement which may be contrary to any law, ordinance, rule, regulation or order of any public authority bearing on the performance of the Work. If the Contractor has reported in writing an error, inconsistency or omission, has promptly stopped the affected work until otherwise instructed, and has otherwise followed the instructions of the Owner, the Contractor shall not be liable to the Owner or the Design Consultant for any damage resulting solely from any such

errors, inconsistencies or omissions in the Contract Documents. The Contractor shall perform no portion of the Work at any time without Contract Documents and, where required, approved Shop Drawings, Product Data or Samples for such portion of the Work.

All designs, drawings, specifications, design calculations, notes and other works provided for this contract are the sole property of the Owner and may not be used on any other design or construction project. The use of the design, including tracings and specifications, by any person or entity, for the purpose other than the Project, shall be at the full risk of such person or entity

SUPERVISION AND CONSTRUCTION PROCEDURES

The Contractor shall supervise and direct the Work, using his best skill and attention. He shall be solely responsible for and have control over all construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract. The Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work and all statutory or legal requirements. This requirement applies continuously throughout contract performance and is not limited to regular working hours.

The Contractor shall be responsible to the Owner for the acts and omissions of his employees, Subcontractors and Sub- subcontractors, suppliers, their agents and employees, and other persons performing any of the Work and for their compliance with each and every requirement of the Contract Documents, in the same manner as if they were directly employed by the Contractor.

The Contractor shall not be relieved from his obligations to perform the Work in accordance with the Contract Documents either by the acts, failures to act or duties of the Owner or the Design Consultant in their administration of the Contract, or by inspections, tests or approvals (or the lack thereof) required or performed under Paragraph 6.5 by persons other than the Contractor.

The Contractor shall verify all grades, lines, levels and dimensions as indicated and shown on the Drawings and Specifications prior to beginning the work and shall immediately report in writing any errors or inconsistencies to the Design Consultant before commencing the work.

Contractor shall protect existing surfaces, finishes and adjacent facilities from damage during construction. Any damage shall be repaired by Contractor at his own expense prior to completion of the Project. Prior to construction start, Contractor and Owner shall perform an inspection to record existing conditions, damaged and undamaged.

LABOR AND MATERIALS

Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for all labor, materials, equipment, supplies, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary or proper for or incidental to the execution and completion of the Work required by and in accordance with the Contract Documents and any applicable code or statute, whether specifically required by the Contract Documents or whether their provision may reasonably be inferred as necessary to produce the intended results, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work. Final payment will not be made until the Work is so completed.

The Contractor shall at all times enforce strict discipline and good order among his employees and shall not employ on the Work any unfit person or anyone not skilled in the task assigned to him. The Owner may, by notice in writing, require the Contractor to remove from the work any employee the Owner deems incompetent, careless or otherwise objectionable. All agents and workers of the Contractor and its Subcontractors shall wear identification badges provided by the Contractor at all times they are on the Owner's property. The identification badges shall at a minimum display the company name, telephone number and employee's picture and name and must be worn in plain view at all times. Additionally, once school staff occupies the building, all contractors and their respective subcontractors shall be required to sign in and out of the visitor's log each day they are performing services. They must also wear a visitor's pass which will indicate to staff that they have met this requirement which applies to anyone performing services anywhere on the school property.

The Contractor shall be responsible for ensuring that the Work is completed in a skillful and workmanlike manner.

All equipment, apparatus and/or devices of any kind to be incorporated into the Work that are shown or indicated on the drawings or called for in the specifications or required for the completion of the work shall be entirely satisfactory to the Owner and the Design Consultant as regards operations, capacity and/or performance. No approval, either written or verbal, of any drawings, descriptive data or samples of such equipment, apparatus and/or device shall relieve the Contractor of his responsibility to turn over the same in good working order for its intended purpose at the completion of the Work in complete accordance with the Contract Documents. Any equipment, apparatus and/or device not fulfilling these requirements shall be removed and replaced by proper and acceptable equipment, etc. or put in good working order satisfactory to the Owner and Design Consultant without additional cost to the Owner.

All materials and Work shall meet North Carolina Building Codes. Should there be any discrepancies between design and code, the more stringent requirement shall apply. All materials shall comply with standards (or approved products) as set by the Specifications. Unless otherwise specified,

NO ASBESTOS CONTAINING MATERIALS SHALL BE INSTALLED. BY DEFINITION, INSTALLATION OF ASBESTOS MATERIALS WILL BE CONSIDERED CONTRACTOR'S NEGLIGENCE AND THE CONTRACTOR SHALL PERFORM ALL NECESSARY WORK TO REMOVE THE ASBESTOS AND RESTORE THE SITE TO THE 'PRE-CONTRACT' CONDITION. Contractor shall assume all facilities built prior to 1979 have lead-based paint. Any paint removal shall be in accordance with OSHA standard pertaining to lead (29 CFR 1915.1025).

WARRANTY

The Contractor warrants to the Owner and the Design Consultant that all materials and equipment furnished under this Contract will be new unless otherwise specified, and that all workmanship will be of first class quality, free from faults and defects and in conformance with the Contract Documents and all other warranties and guaranties specified therein. Where no standard is specified for such workmanship or materials, they shall be the best of their respective kinds. All Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. If required by the Owner or the Design Consultant, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment. This warranty is not limited by the provisions of Article 11.

The warranties set forth in this Paragraph 3.5 and elsewhere in the Contract Documents shall survive Final Completion of the Work.

If, within one year after the Date of Substantial Completion of the Work or designated portion thereof or within one year after acceptance by the Owner of designated equipment or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be defective, not in accordance with the Contract Documents, or not in accordance with the guarantees and warranties specified in the Contract documents, the Contractor shall correct it within five (5) working days or such other period as mutually agreed, after receipt of a written notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice with reasonable promptness after discovery of the condition. For items, which remain incomplete or uncorrected on the date of Substantial Completion, the one-year warranty shall begin on the date of Final Completion of the Work. If the Contract Documents include painting work, the one year warranty period in this section shall be extended to two years.

If at any time deficiencies in the Work are discovered which are found to have resulted from fraud or misrepresentation, or an intent or attempt to or conspiracy to defraud the Owner by the Contractor, any Subcontractor or Supplier, the Contractor will be liable for replacement or correction of such Work and any damages which Owner has incurred related thereto, regardless of the time limit of any guarantee or warranty.

The Contractor shall bear the cost of making good all work of the Owner, separate contractors or others, destroyed or damaged by such correction or removal required under this Article 3, Article 11 or elsewhere in the Contract Documents.

TAXES

The Contractor shall pay all sales, consumer, use and other similar taxes for the Work or portions thereof provided by the Contractor which are legally enacted at the time bids are received, whether or not yet effective. The Contractor shall indemnify and hold the Owner harmless from any claims arising out of the Contractor's failure to pay all required taxes, including claims by the county for its inability to recover taxes that were not properly paid to the State of North Carolina by the Contractor.

The Contractor shall provide a completed Contractor's Sales Tax Report (attached hereto as Appendix A) with each application for payment for all items provided by the Contractor or any Sub-Contractors and incorporated into this project. The Contractor shall account for at least 2% of the total contract amount in sales tax or provide justification satisfactory to the Owner that the actual sales tax paid is less than 2%. In the event the Contractor does not provide adequate justification to support the shortfall, the Contractor shall pay the Owner the difference between the amount accounted for and the 2% minimum. Such compensation shall not be deemed a penalty, but reimbursement of funds the Owner would otherwise be entitled to recover from the State.

Sales and Use Tax. Contractor shall be responsible for complying with any applicable sales and use tax obligations imposed by Chapter 105, Article 5 of the North Carolina General Statutes. Where Contractor has been contracted with to oversee "new construction" or "reconstruction" as defined in G.S. 105-164.4H, Contractor shall be responsible for issuing and maintaining an Affidavit of Capital Improvement.

PERMITS, FEES AND NOTICES

The Contractor shall secure and pay for the building permit and for all other permits and governmental fees necessary for the proper execution and completion of the Work. Costs for service and final service connections by public utilities will be reimbursed to the Contractor by the Owner. The Owner shall not be responsible for the cost of any temporary utilities.

The Contractor will pay for his license and reinspection fees for the work necessary for the proper execution and completion of the work.

The Contractor shall give all notices and comply with all laws, ordinances, rules, regulations and lawful orders of any public authority bearing on the performance of the Work.

PROGRESS SCHEDULE

The Contractor shall prepare and submit to the Owner for the Owner's review and approval an estimated progress schedule for the Work. This schedule shall be in accordance with any general requirements included in the Specifications for this project.

RESPONSIBILITY FOR COMPLETION

The Contractor shall furnish such manpower, materials, facilities and equipment and shall work such hours, including night shifts, overtime operations and Sundays and holidays, as may be necessary to ensure the performance of the Work within the Milestone and Completion dates specified in the Owner-Contractor Agreement.

If the actions taken by the Contractor are not satisfactory, the Design Consultant or Owner may direct the Contractor to take any and all actions necessary to ensure completion within the required Milestone and Completion dates, without additional cost to the Owner. In such event, the Contractor shall continue to assume responsibility for his performance and for completion within the required dates.

DOCUMENTS AND SAMPLES AT THE SITE

The Contractor shall maintain at the site for the Owner one record copy of all Drawings, Specifications, Addenda, Change Orders and other Modifications, in good order and marked currently to record all changes made during construction, and approved Shop Drawings, Product Data and Samples. These shall be delivered to the Owner upon completion of the Work.

SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

The Contractor shall review, approve and submit, with reasonable promptness and in such sequence as to cause no delay in the Work or in the work of the Owner or any separate contractor, all Shop Drawings, Product Data, Manuals and Samples required by the Contract Documents.

Do not order materials until receipt of written approval. Furnish materials equal in every respect to approved samples.

By approving and submitting Shop Drawings, Product Data, Manuals and Samples, the Contractor represents that he has determined and verified all materials, field measurements, and field construction criteria related thereto, and that he has checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents. The Contractor shall adhere to any supplementary processing and scheduling instructions pertaining to Shop Drawings, which may be issued by the Design Consultant.

The Contractor shall not be relieved of responsibility for any deviation from the requirements of the Contract Documents by the Design Consultant's review of Shop Drawings, Product Data, Samples or Manuals under unless the Contractor has specifically informed the Design Consultant in writing of such deviation at the time of submission and the Design Consultant has given written approval to the specific deviation. The Contractor shall not be relieved from responsibility for errors or omissions in the Shop Drawings, Product Data, Samples, or Manuals by the Design Consultant's review thereof.

The Contractor shall make corrections required by the Design Consultant and shall resubmit the required number of corrected copies of Shop Drawings or new Product Data or Samples. The Contractor shall direct

specific attention, in writing or on resubmitted Shop Drawings, Product Data or Samples, to revisions other than those requested by the Design Consultant on previous submittals. Resubmittals necessitated by required corrections due to Contractor's errors or omissions shall not be cause for extension of Contract Time, and any costs associated with the processing of these resubmittals shall be paid by the Contractor.

No portion of the Work requiring submission of Shop Drawings, Product Data, Samples or Manuals shall be commenced until the submittal has been approved by the Design Consultant. All such portions of the Work shall be in accordance with approved submittals.

EQUAL PRODUCTS AND SUBSTITUTIONS

All materials, supplies and articles furnished under this Contract shall, whenever specified and otherwise practicable, be the standard products of recognized, reputable manufacturers. Unless otherwise specifically provided in the Contract Documents, the naming of a certain brand, make, manufacturer or article, device, product, material, fixture or type of construction shall convey the general style, type, character and standard of quality of the article desired and shall not be construed as limiting competition. The Contractor, in such cases, may with Design Consultant and Owner approval, use any brand, make, manufacturer, article, device, product, material, fixture, form or type of construction which in the judgment of the Design Consultant is equal to that specified. An item may be considered equal to the item so named or described if, in the opinion of the Owner and Design Consultant (1) it is at least equal in quality, durability, appearance, strength, and design; (2) it will perform at least equally the specific function imposed by the general design for the work being contracted for or the material being purchased; and (3) it conforms substantially, even with deviations, to the detailed requirements for the item in the specifications. Approval by the Owner and Design Consultant will be granted based upon considerations of quality, workmanship, economy of operation, suitability for the purpose intended, and acceptability for use on the Project.

Contractor must provide evidence that proposed substitution does not require revisions to the Contract Documents, that is consistent with Contract Documents, and will produce the indicated results, and is comparable with other portions of the Work. Contractor must provide a detailed comparison of significant qualities or proposed substitution with those of the Work specified, including but not limited to the following significant qualities: performance, weight, size, durability, visual effect, sustainable design features, warranties, and any specific features and requirements indicated in Contract Documents. An annotated copy of applicable Specification section and point-by-point comparison between specified product and the proposed substitution describing each point of compliance, non-compliance, and variance between the specified and proposed product shall be provided.

USE OF SITE

The Contractor shall confine operations at the site to areas permitted by law, ordinances, permits, easements, right-of-way agreements and the Contract Documents. The Contractor shall not unreasonably encumber the site, in the opinion of the Owner, with any materials, equipment or trailers nor shall he block the entrances or otherwise prevent reasonable access to the site, other working and parking areas, completed portions of the Work and/or properties, storage areas, areas of other facilities that are adjacent to

the worksite. If the Contractor fails or refuses to move said material, equipment or trailers within 24 hours of notification by the Owner, to so do, the Owner shall have the right, without further notice, to remove, at the Contractor's expense, any material, equipment and/or trailers which the Owner deems are in violation of this paragraph.

CUTTING AND PATCHING OF WORK

The Contractor shall not damage or endanger any portion of the Work or the work of the Owner or any separate contractors by cutting, patching or otherwise altering any work, or by excavation.

Existing structures and facilities including but not limited to building, utilities, topography, streets, curbs, walks, etc., that are damaged or removed due to required excavations or other construction work, shall be patched, repaired or replaced by the Contractor to satisfaction of the Design Consultant and the Owner of such structures and facilities and authorities having jurisdiction.

CLEANING UP

The Contractor at all times shall keep the premises free from accumulation of waste materials or rubbish caused by his operations. If the Contractor fails to clean up during or at the completion of the Work, the Owner may do so and the cost thereof shall be charged to the Contractor.

INDEMNIFICATION

To the fullest extent permitted by law, the Contractor shall, at his sole cost and expense, indemnify, defend, and hold harmless the Owner and the Design Consultant and their agents, representatives, and employees from and against all claims, actions, judgments, costs, liabilities, penalties, damages, losses and expenses, including but not limited to attorneys' fees, arising out of or caused by any negligent act, error, omission or breach of this Agreement by the Contractor, any Subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable. The above obligation shall not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity, which would otherwise exist as to any party or person, described in this Paragraph 3.16. The parties agree that this indemnification clause is an "evidence of indebtedness" for purpose of N.C. Gen. Stat. § 6-21.2. The parties also specifically acknowledge that the Owner is a public body and it is the intent of the parties that the Owner not incur any expenses when the Contractor is solely responsible for the claims. Contractor's indemnity obligations to Owner in the Contract Documents shall survive the expiration or termination of the Contract Documents.

In any and all claims against the Owner or the Design Consultant or any of their agents, representatives, or employees by any employee of the Contractor, any Subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, the indemnification obligation under this Paragraph 3.16 shall not be limited in any way by Contractor's insurance coverage required herein.

No provision of this Paragraph 3.16 shall give rise to any duties on the part of the Design Consultant or the Owner, or any of their agents, representatives, or employees.

CONDITIONS AFFECTING THE WORK

The Contractor shall be responsible for taking all steps necessary to ascertain the nature and location of the Work and the general and local conditions, which can affect the Work or the cost thereof. The Owner assumes no responsibility for any understanding or representation about conditions affecting the Work made by any of his officers, employees, representatives, or agents prior to the execution of the Contract, unless such understandings or representations are expressly stated in the Contract Documents.

Miscellaneous.

The Contractor shall provide documentation acceptable to the Owner showing the amount of MBE participation (including a complete list of all subcontractors and their final subcontract amounts) and sales tax paid by the Contractor and its subcontractors for materials purchased for Projects completed under this contract. The Contractor agrees to comply with the all of the Owner's policies at all times that the Contractor, its subcontractors and employees are on the Owner's property. The Contractor acknowledges that the Owner's policies can be accessed and viewed at the Owner's website. The Contractor shall comply with the Owner's site or school building access procedures when working on any existing school campus.

APPLICABLE LAWS

This Contract and the relationship of the parties shall be governed by the laws of the state of North Carolina.

Contractor shall comply with all applicable laws and regulations in providing services under this Contract. Contractor shall not employ any individuals to provide services to the Owner who are not authorized by federal law to work in the United States. The Contractor represents that it is aware of and in compliance with the Immigration Reform and Control Act and North Carolina law (Article 2 of Chapter 64 of the North Carolina General Statutes) requiring use of the E-Verify system. The Contractor further warrants that it will use the E-Verify system to verify employment eligibility of all its employees throughout the term of this Contract, and that it will remain in compliance with all I-9 requirements throughout the term of this Contract. The Contractor shall also ensure that any subcontractors use the E-Verify system at all times while providing subcontracted services in connection with this Contract. Contractor is responsible for providing affordable health care coverage to all of its full-time employees providing services to the school system. The definitions of "affordable coverage" and "full-time employee" are governed by the Affordable Care Act and accompanying IRS and Treasury Department regulations.

The Contractor also acknowledges that G.S. § 14-208.18 prohibits anyone required to register as a sex offender under Article 27A of Chapter 14 of the General Statutes from knowingly being on the premises of any school. The Contractor shall conduct or arrange to have conducted, at its own expense, sexual offender registry checks on each of its employees, agents, ownership personnel, or contractors ("contractual personnel") who will engage in any service on or delivery of goods to school system property or at a school-system sponsored event, except checks shall not be required for individuals who are solely delivering or picking up equipment, materials, or supplies at: (1) the administrative office or loading dock of a school; (2) non-school sites; (3) schools closed for renovation prior to substantial completion; or (4) new school construction sites prior to substantial completion. The checks shall include at a minimum checks of the State

Sex Offender and Public Protection Registration Program, the State Sexually Violent Predator Registration Program, and the National Sex Offender Registry ("the Registries"). For the Contractor's convenience only, all of the required registry checks may be completed at no cost by accessing the United States Department of Justice Sex Offender Public Website at <http://www.nsopw.gov/>. The Contractor shall provide certification on the Sexual Offender Registry Check Certification Form (attached as Appendix C) that the registry checks were conducted on each of its contractual personnel providing services or delivering goods under this Agreement prior to the commencement of such services or the delivery of such goods. With each pay application, the Contractor shall provide an updated list of all Project subcontractors, identifying the date the subcontractor is anticipated to first be on the site, and the status of receipt of the Completed Sexual Offender Registry Check Certification Form from each subcontractor. The Contractor shall conduct a current initial check of the registries (a check done more than 30 days prior to the date of this Agreement shall not satisfy this contractual obligation). In addition, the Contractor agrees to conduct the registry checks and provide a supplemental certification form before any additional contractual personnel are used to deliver goods or provide services pursuant to this Agreement. The Contractor further agrees to conduct annual registry checks of all contractual personnel and provide annual certifications at each anniversary date of this Agreement. The Contractor shall not assign any individual to deliver goods or provide services pursuant to this Agreement if said individual appears on any of the listed registries. The Contractor agrees that it will maintain all records and documents necessary to demonstrate that it has conducted a thorough check of the registries as to each contractual personnel, and agrees to provide such records and documents to the Owner upon request. The Contractor specifically acknowledges that the Owner retains the right to audit these records to ensure compliance with this section at any time in the Owner's sole discretion. Failure to comply with the terms of this provision shall be deemed a material breach of the Agreement. In addition, the Owner may conduct additional criminal records checks at the Owner's expense. If the Owner exercises this right to conduct additional criminal records checks, the Contractor agrees to provide within seven (7) days of request the full name, date of birth, state of residency for the past ten years, and any additional information requested by the Owner for all contractual personnel who may deliver goods or perform services under this Agreement. The Contractor further agrees that it has an ongoing obligation to provide the Owner with the name of any new contractual personnel who may deliver goods or provide services under the Agreement. The Owner reserves the right to prohibit any contractual personnel of the Contractor from delivering goods or providing services under this Agreement if the Owner determines, in its sole discretion, that such contractual personnel may pose a threat to the safety or well-being of students, school personnel or others.

Anti-Nepotism. Contractor warrants that, to the best of its knowledge and in the exercise of due diligence, none of its corporate officers, directors, or trustees and none of its employees who will directly provide services under this Agreement are immediate family members of any member of the Board of Education or of any principal or central office staff administrator employed by the Board. For purposes of this provision, "immediate family" means spouse, parent, child, brother, sister, grandparent, or grandchild, and includes step, half, and in-law relationships. Should Contractor become aware of any family relationship covered by this provision or should such a family relationship arise at any time during the term of this Agreement, Contractor shall immediately disclose the family relationship in writing to the Superintendent of the Schools. Unless formally waived by the Board, the existence of a family relationship covered by this Agreement is grounds for immediate termination by Owner without further financial liability to Contractor.

Restricted Companies Lists. Provider represents that as of the date of this Contract, Provider is not included on the Final Divestment List created by the North Carolina State Treasurer pursuant to N.C. Gen. Stat. § 147-86.58. Provider also represents that as of the date of this Contract, Provider is not included on

the list of restricted companies determined to be engaged in a boycott of Israel created by the North Carolina State Treasurer pursuant to N.C. Gen. Stat. § 147-86.81.

COMPLIANCE WITH BOARD POLICIES AND PROCEDURES

The Contractor acknowledges that Board policies are available for review at the Owner's website and agrees to comply with the policies. The Contractor also agrees to comply with the following provisions:

The Contractor, its Subcontractors and employees shall not possess or carry, whether openly or concealed, any gun, rifle, pistol, or explosive on any property owned by the Owner. This includes firearms locked in containers, vehicles or firearm racks within vehicles. The Contractor, its Subcontractors and employees shall not cause, encourage or aid a minor, who is less than 18 years old to possess or carry, whether openly or concealed, any weapons on any property owned by the Owner.

The Contractor, its Subcontractors and employees, are prohibited from profane, lewd, obscene or offensive conduct or language, including engaging in sexual harassment.

The Contractor and its Subcontractors shall not manufacture, transmit, conspire to transmit, possess, use or be under the influence of any alcoholic or other intoxicating beverage, narcotic drug, hallucinogenic drug, amphetamine, barbiturate, marijuana or anabolic steroids, or possess, use, transmit or conspire to transmit drug paraphernalia on any property owned by the Owner.

The Contractor and its Subcontractors may not at any time use or display tobacco or nicotine-containing products, including but not limited to electronic cigarettes (e-cigarettes), on school premises, both indoor and outdoor. The prohibition of the display of tobacco or nicotine products shall not extend to a display that has a legitimate instructional or pedagogical purpose. For purposes of this Contract, "tobacco product" is defined to include cigarettes, cigars, blunts, bidis, pipes, chewing tobacco, snuff, and any other items containing or reasonably resembling tobacco, tobacco products, or any facsimile thereof. "Tobacco use" includes smoking, chewing, dipping, or any other use of tobacco products.

The Contractor, its Subcontractors and employees shall not solicit from or sell to students or staff within the Owner's facilities or campuses, and shall not give gifts of any value to school system employees.

Operators of all commercial vehicles on any property owned by the Owner shall be subject to post-accident, random, reasonable suspicion and follow-up testing for drugs and alcohol.

The Contractor, its Subcontractors and employees are prohibited from using access to the site pursuant to this Agreement as a means to date, court, or enter into a romantic or sexual relationship with any student enrolled in the School System. The Contractor agrees to indemnify the Owner for claims against the Owner resulting from relationships which have occurred or may occur between a student and an employee of the Contractor or Subcontractor.

MINORITY AND HISTORICALLY UNDERUTILIZED BUSINESS

If the Contract Sum is \$300,000 or greater, the Contractor shall make a good faith effort to utilize minority and Historically Underutilized Businesses (HUBs) as defined and required in N.C. Gen. Stat. 143-128.2 to -128.4. The Contractor shall identify in the list of its Subcontractors, those Subcontractors that are (HUBs) and indicate the portion of the Work that each Subcontractor will perform. If during the duration of the Project, the Contractor effects a substitution for any Subcontractor, or if additional subcontract opportunities become available, the Contractor shall make a good faith effort to utilize HUBs. The Contractor shall submit with each Application for Payment a list of those HUBs whose work is included in the application and the amount due each. Failure or refusal of the Contractor to submit the required information on HUBs shall be grounds to withhold payment.

END OF ARTICLE 3

ARTICLE 4

SUBCONTRACTORS

AWARD OF SUBCONTRACTS AND OTHER CONTRACTS FOR PORTIONS OF THE WORK

The Contractor, in compliance with the requirements of the Contract Documents, shall furnish in writing to the Owner the names of the persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each of the principal portions of the Work. The Owner will promptly reply to the Contractor in writing stating whether or not the Owner, after due investigation, has reasonable objection to any such proposed person or entity.

The Contractor shall identify in the list of names of the Subcontractors proposed, those Subcontractors that are Minority Business Enterprises and the date each is planned to begin work on the project. If during the duration of the project, the Contractor effects a substitution for any Subcontractor, or if additional subcontract opportunities become available, the Contractor shall make a good faith effort to utilize Minority Business Enterprises. At the completion of the project, the Contractor shall provide documentation acceptable to the Owner showing the amount of MBE participation (including a complete list of all subcontractors and their final subcontract amounts).

END OF ARTICLE 4

ARTICLE 5

WORK BY OWNER OR BY SEPARATE CONTRACTORS

OWNER'S RIGHT TO PERFORM WORK AND TO AWARD SEPARATE CONTRACTS

The Owner reserves the right to perform work related to the Project with his own forces, and to award separate contracts in connection with other portions of the Project or other work on the site under these or similar Conditions of the Contract.

MUTUAL RESPONSIBILITY

Should the Contractor cause damage to the work or property of the Owner or of any separate contractor on the Project, or to other work on the Site, or delay or interfere with the Owner's work on ongoing operations or facilities or adjacent facilities or said separate contractor's work, the Contractor shall be liable for the same; and, in the case of another contractor, the Contractor shall attempt to settle said claim with such other contractor prior to such other contractor's institution of litigation or other proceedings against the Contractor.

Should a separate contractor cause damage to the Work or to the property of the Contractor or cause delay or interference with the Contractor's performance of the Work, the Contractor shall present directly to said separate contractor any claims it may have as a result of such damage, delay or interference (with an information copy to the Owner) and shall attempt to settle its claim against said separate contractor prior to the institution of litigation or other proceedings against said separate contractor.

In no event shall the Contractor seek to recover from the Owner or the Design Consultant, and the Contractor hereby waives any claims against the Owner and Design Consultant relating to any costs, expenses (including, but not limited to, attorney's fees) or damages or other losses incurred by the Contractor as a result of any damage to the Work or property of the Contractor or any delay or interference caused by any separate contractor.

COORDINATION OF THE WORK

By entering into this contract, Contractor acknowledges that there may be other contractors on the site whose work will be coordinated with that of his own. Contractor expressly warrants and guarantees that he will cooperate with other contractors and will do nothing to delay, hinder or interfere with the work of other separate contractors, the Owner or Design Consultant. Contractor also expressly agrees that, in the event his work is hindered, delayed, interfered with or otherwise affected by a separate contractor, his sole remedy will be a direct action against the separate contractor as described in this Article 5. Contractor will have no remedy, and hereby expressly waives any remedy, against the Owner and/or the Design Consultant on account of delay, hindrance, interference or other event caused by a separate contractor.

END OF ARTICLE 5

ARTICLE 6

MISCELLANEOUS PROVISIONS

GOVERNING LAW

This contract shall be governed by the law of the State of North Carolina. The Contractor and Owner agree that county where the Project is located shall be the proper venue for any litigation arising out of this Agreement.

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

CLAIMS AND DAMAGES

Should the Contractor or any of its Subcontractors suffer injury or damage to person or property because of any act or omission of the Owner or Design Consultant, or of any of their employees, agents or others for whose acts either is legally liable, the claim on behalf of the Contractor or its subcontractors shall be made in writing to the Owner within 10 days after the first observance of such injury or damage; otherwise, the Contractor shall have waived any and all rights he may have against the Owner or the Design Consultant, or their employees, representatives and agents. The Contractor shall indemnify, defend and hold the Owner harmless from any claim by a Subcontractor that is waived because it is not filed in strict conformance with this paragraph or any other provision of this Agreement regarding claims.

RIGHTS AND REMEDIES

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

Except as may be specifically agreed in writing, the failure of the Owner or the Design Consultant to insist in any one or more instances upon the strict performance of any one or more of the provisions of this Contract, or to exercise any right herein contained or provided by law, shall not be construed as a waiver or relinquishment of the performance of such provisions or right(s) or of the right to subsequently demand such strict performance or exercise such right(s), and the rights shall continue unchanged and remain in full force and effect.

The Contractor agrees that he can be adequately compensated by money damages for any breach of this Contract which may be committed by the Owner and hereby agrees that no default, act, or omission of the Owner or the Design Consultant, except for failure to make progress payments as required by the Contract Documents, shall constitute a material breach of the Contract entitling the Contractor to cancel or rescind the provisions of this Contract or (unless the Owner shall so consent or direct in writing) to suspend or abandon performance of all or any part of the Work. The Contractor hereby waives any and all rights and remedies to which he might otherwise be or become entitled, save only his right to money damages.

Contractor and Owner acknowledge that the Contract Documents shall not be construed against Owner due to the fact that they may have been drafted by Owner. For purposes of construing the Contract Documents, both Contractor and Owner shall be considered to have jointly drafted the Contract Documents.

In the event that Owner incurs attorney's fees or litigation expenses in connection with enforcing or protecting its rights under the Contract Documents or defending any claim or lawsuit brought against it arising out of the Work or the Contract Documents, Contractor shall reimburse Owner for such reasonable attorney's fees and expenses.

TESTS

If the Contract Documents, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any portion of the Work to be inspected, tested, or approved, the Contractor shall give the Owner timely notice of its readiness so the Design Consultant and the Owner may observe such inspection, testing or approval. The Contractor shall bear all costs of such inspections, tests or approvals conducted by public authorities. Unless otherwise provided, the Owner shall bear all costs of other inspections, tests or approvals, except the Contractor shall be responsible for the cost of any reinspection, including the rescheduling of an inspection requested by the Contractor prior to proper the completion of the work to be inspection.

Unless otherwise stipulated in other Contract Documents, the Contractor shall pay for all utilities required for testing of installed equipment of all of his work and work of each Subcontractor. Boiler fuel other than gas shall be provided by Subcontractor furnishing boilers. Labor and supervision required for making such tests shall be provided at no additional cost to the Owner.

If the Design Consultant or the Owner determines that any Work requires special inspection, testing, or approval which Subparagraph 6.5.1 does not include, the Owner will instruct the Contractor to order such special inspection, testing or approval, and the Contractor shall give notice as provided in Subparagraph 6.5.1. If such special inspection or testing reveals a failure of the Work to comply (1) with the requirements of the Contract Documents, or (2) with respect to the performance of the Work, with laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction, the Contractor shall bear all costs thereof, including compensation for the Design Consultant's and Owner's additional construction management expenses made necessary by such failure.

UNENFORCEABILITY OF ANY PROVISION

If any provision of this Contract is held as a matter of law to be unenforceable or unconscionable, the remainder of the Contract shall be enforceable without such provision.

ATTORNEYS' FEES AND OTHER EXPENSES

The Contractor hereby agrees that he will not submit, assert, litigate or otherwise pursue any frivolous or unsubstantiated claims or claims he has specifically waived under the terms of the Contract Documents. In the event that the Contractor's or its Subcontractor's claims, or any separate item of a claim, is without substantial justification, the Contractor shall reimburse the Owner or Design Consultant for all costs and expenses associated with defending such claim or separate item, including but not limited to, attorneys' fees, audit costs, accountants' fees, expert witness' fees, additional Design Consultant expenses, additional construction management expenses, or services and any other consultant costs.

If the Contractor breaches any obligation under the Contract Documents, the Contractor shall reimburse the Owner and Design Consultant for all costs and expenses incurred by the Owner relating to such breach, including but not limited to attorneys' fees, audit costs, accountants' fees, expert witness' fees, additional Design Consultant expenses, additional construction management expenses, and any other consultant costs.

If the Owner or Design Consultant prevails in a claim brought against the Contractor, including but not limited to, claims for fraud or misrepresentation, overpayment, defective work, delay damages, and recovery of termination expenses, the Contractor shall reimburse the Owner and Design Consultant for all costs and expenses incurred by them relating to such claim, including but not limited to attorneys' fees, audit costs, accountants' fees, expert witness' fees, additional Design Consultant expenses, additional construction management expenses, and any other consultant costs.

END OF ARTICLE 6

ARTICLE 7

TIME

DEFINITIONS

Unless otherwise provided, the Contract Time is the period of time allotted in the Contract Documents for Substantial and Final Completion of the Work, as defined in Subparagraph 7.1.3 and 7.1.4, including any allowances and alternates. The Contractor shall complete his Work within Contract Time, unless the Contract Time is modified.

The date of commencement of the Work is the date established in a notice to proceed. If there is no notice to proceed, it shall be the date of the Owner-Contractor Agreement or such other date as may be established therein. The Contractor shall not commence Work or store materials or equipment on site until written Notice to Proceed is issued or until the Contractor otherwise receives the Owner's written consent.

DELAYS AND EXTENSIONS OF TIME

The time during which the Contractor or any of its subcontractors delayed in the performance of the Work by the acts or omissions of the Owner, Design Consultant or their employees or agents, acts of God, unusually severe and abnormal climatic conditions, fires, floods, epidemics, quarantine restrictions, strikes, riots, civil commotions or freight embargoes, or other conditions beyond the Contractor's or its subcontractors' control and which the Contractor or its subcontractors could not reasonably have foreseen and provided against, shall be added to the time for completion of the Work (i.e., the Contract Time) stated in the Owner-Contractor Agreement; provided, however, that no claim by the Contractor for an extension of time for delays will be considered unless made in strict compliance with the requirements of this Article and other provisions of the Contract Documents.

For excessive inclement weather, the Contract Time will not be extended due to reasonably anticipated inclement weather or for delays in the aftermath of inclement weather, reasonably anticipated or excessive. The time for performance of this Contract, as stated in the Contract Documents, includes an allowance for calendar days which may not be available for construction out-of-doors; for the purposes of this Contract, the Contractor agrees that the number of calendar days per month based on a five-year average shall be considered reasonably anticipated inclement weather and planned for in the construction schedule per the Contract. Unless the Contractor can substantiate to the satisfaction of the Owner that there was greater than the reasonably anticipated inclement weather considering the time from the notice-to-proceed until the building is enclosed using data from the national weather service station identified in the supplemental conditions or a weather station acceptable to the Owner and that such alleged greater than reasonably anticipated inclement weather actually delayed the Work or portions thereof which had an effect upon the Contract Time, the Contractor shall not be entitled to an extension of time.

Also the Contractor agrees that the calculation of the number of excessive inclement weather days shall be the number of days in excess of the five-year average for each month, in which precipitation exceeded one tenth (.10) inch, or in which the highest temperature was 32 degrees F or less as recorded at the approved weather station. Rain days from hurricanes and tropical storms not causing damage in in the county where the Project is located shall be deemed inclement weather days.

If the total accumulated number of calendar days lost to excessive inclement weather, from the notice-to-proceed until the building is enclosed, exceeds the total accumulated number to be reasonably anticipated for the same period from the table above, time for completion will be extended by the number of calendar days needed to include the excess number of calendar days lost. No extension of time will be made for days due to excessive inclement weather occurring after the building is enclosed or for contracts that do not include work out of doors that is not on the critical path. For the purpose of this Contract, the term "enclosed" is defined to mean when the building is sufficiently roofed and sealed, either temporarily or permanently, to permit the structure to be heated and the plastering and dry-wall trades to work. The Design Consultant shall determine when the structure is "enclosed". Upon the request of either party, the Design Consultant shall issue a letter certifying to the Owner, with a copy to the Contractor, stating the date the building became enclosed. No change in Contract Sum will be authorized because of adjustment of Contract time due to excessive inclement weather.

Should a time extension be granted for Substantial Completion the date for Final Completion shall be appropriately adjusted unless specifically stated otherwise.

Neither the Owner nor the Design Consultant shall be obligated or liable to the Contractor or its Subcontractors for, and the Contractor hereby expressly waives any claims against the Owner and the Design Consultant on account of any indirect or direct damages, costs or expenses of any nature which the Contractor, its Subcontractors, or Sub-subcontractors or any other person may incur as a result of any delays, interferences, changes in sequence or the like, which are reasonable, foreseeable, contemplated, or avoidable by Contractor, and it is understood and agreed that the Contractor's sole and exclusive remedy in any such events shall be an extension of the Contract Time in accordance with the Contract Documents, unless the delays, interferences, changes in sequence or the like arise solely from or out of any act or omission of the Owner or the Design Consultant, or their agents, employees, consultants or independent. The Contractor shall not be entitled to any damages or extensions of time pursuant to this section for concurrent delays for which the Contractor is at least partially responsible.

Subject to other provisions of the Contract Documents, the Contractor may be entitled to an extension of the Contract Time (but no increase in the Contract Sum) for delays arising from unforeseeable causes beyond the control and without the fault or negligence of the Contractor, his Subcontractors or suppliers, unless caused solely by the Owner or Design Consultant

The Contractor and its subcontractors shall not be entitled to and hereby expressly waives any extension of time resulting from any condition or cause unless said claim for extensions of time is made in writing to the Owner within ten (10) days of the first instance of delay.

END OF ARTICLE 7

ARTICLE 8

PAYMENTS AND COMPLETION

SCHEDULE OF VALUES

Before the first Application for Payment, the Contractor shall submit to the Owner a schedule of values allocated to the various portions of the Work.

APPLICATIONS FOR PAYMENT

Prior to the date for each progress payment established in the Owner-Contractor Agreement, the Contractor, shall submit to the Owner an itemized Application for Payment including a completed Contractor's Sales Tax Report (attached hereto as Appendix A) for all items provided by the Contractor or any Subcontractors included in the application. The Contractor shall also certify that he has paid all due and payable amounts for which previous certificates for payment were issued and payments received from the Owner and that the work for which payment is requested has been completed.

The Owner will retain funds from each progress payment to the maximum extent allowed by N.C. General Statute 143-134.1 until the Work is finally completed and accepted, whether or not the Owner has occupied any or all of the Project before such time. If a reduction in retainage has been made or the Owner stops withholding retainage for any reason, the Owner may increase or commence the retainage as authorized by N.C. Gen. Stat. 143-134.1.

Owner will be under no obligation to make payment to the Contractor on account of materials or equipment not incorporated in the Work. Materials once paid for by the Owner become the property of the Owner and may not be removed from the work site without the Owner's written permission.

The Contractor warrants that title to all Work, materials and equipment covered by an Application for Payment will pass to the Owner either by incorporation in the construction or upon the receipt of payment by the Contractor, whichever occurs first, free and clear of all liens, claims, security interests or encumbrances, hereinafter referred to in this Article 8 as "liens".

All invoices shall show the following:

Total amount of contract

Amount of change orders

Total value of completed work

Amount retained by Owner

Amount due Contractor

CERTIFICATES FOR PAYMENT

By signing a Certificate for Payment, the Design Consultant shall not thereby be deemed to represent that it has made exhaustive or continuous on-site inspections to check the quality or quantity of the Work or that it has reviewed the construction means, methods, techniques, sequences, or procedures, or that it has made any examination to ascertain how or for what purpose the Contractor has used the moneys previously paid on account of the Contract Sum.

PROGRESS PAYMENTS

The Contractor shall promptly pay each Subcontractor (including suppliers, laborers, and material-men) performing labor or furnishing material for the Work, upon receipt of payment from the Owner.

No Certificate for a progress payment, nor any progress payment, nor any partial or entire use or occupancy of the Project by the Owner, shall constitute an acceptance of any Work not in accordance with the Contract Documents.

The Contractor shall not submit more than one pay application during any 30-day period.

PAYMENTS WITHHELD

The Design Consultant may decline to certify payment and may withhold their Certificate in whole or in part, to the extent the Design Consultant deems necessary to reasonably protect the Owner from loss associated with unsatisfactory job progress, defective construction, disputed work, claims or any other similar issue. The Design Consultant may also decline to certify payment if the Contractor fails to provide Subcontractor information regarding the use of HUBs and/or sexual registry checks. If the Design Consultant is unable to make representations to the Owner and to certify payment in the amount of the Application, it will notify the Contractor as provided herein. The Design Consultant may also decline to certify payment because of subsequently discovered evidence or subsequent observations that may nullify the whole or any part of any Certificate for Payment previously issued to such extent as may be necessary in its opinion to protect the Owner from loss.

FAILURE OF PAYMENT

Payments due and unpaid under the Contract Documents shall not bear interest.

SUBSTANTIAL COMPLETION

The Date of Substantial Completion of the Work or designated portion thereof is the Date certified by the Design Consultant and Owner when the Work or a designated portion thereof is sufficiently complete, in accordance with the Contract Documents, so Owner can fully occupy and utilize the Work for the use for which it is intended, with all of the Project's parts and systems operable as required by the Contract Documents. Only incidental corrective work and any final cleaning beyond that needed for Owner's full use may remain for Final Completion. The Contractor shall be solely responsible for the cost to repair or replace any work damaged or destroyed prior to the Date of Substantial Completion.

When the Design Consultant and the Owner on the basis of an inspection jointly determine that the Work or designated portion thereof is substantially complete, they will then prepare a Certificate of Substantial Completion which shall establish the Date of Substantial Completion, shall state the responsibilities of the Owner and the Contractor for security, maintenance, heat, utilities, damage to the Work, and insurance, and shall fix the time within which the Contractor shall complete the items listed therein. 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. The Contractor shall provide operation & maintenance manuals, and operation training to the Owner as required by the Contract Documents prior to Substantial Completion. The Owner's occupancy of incomplete work shall not alter the Contractor's responsibilities pursuant to this section.

The acceptance of Substantial Completion payment shall constitute a waiver of all claims by the Contractor and its Subcontractors except those previously made in writing and identified by the Contractor as unsettled

at the time the Contractor submits the Application for Payment for Substantial Completion, and except for the retainage sums due at final acceptance. The Contractor shall indemnify and hold the Owner harmless against any claims by its Subcontractors that are waived because they were not made in writing and identified by the Contractor as unsettled when the Contractor submitted the Application for Payment for Substantial Completion.

The issuance of the Certificate of Substantial Completion does not indicate final acceptance of the project by the Owner, and the Contractor is not relieved of any responsibility for the project except as specifically stated in the Certificate of Substantial Completion.

There will be two inspections by the Design Consultant at Substantial Completion:

To generate a list of items to be completed or corrected before Owner takes possession of the Work.

To check that the list of items has been completed before issuing Final Payment.

Any additional inspections by the Design Consultant requested by Contractor to complete the Punch List shall result in money being withheld from the Final Payment to cover the cost of these additional inspections.

FINAL COMPLETION AND FINAL PAYMENT

The date of Final Completion of the work is the date certified by the Design Consultant and the Owner when the Work is totally complete, to include punch list work, in accordance with the Contract Documents and the Owner may fully occupy and utilize the work for the use for which it is intended. The issuance of a temporary or final certificate of occupancy shall not, in itself, constitute Final Completion.

When the Design Consultant and the Owner find the Work acceptable under the Contract Documents and the Contract fully performed, they will approve a final Certificate of Payment stating that to the best of their knowledge, information and belief, and on the basis of their observations and inspections, the Work has been completed in accordance with the terms and conditions of the Contract Documents and that the entire balance found to be due the Contractor, and noted in said final Certificate, is due and payable, except for an amount mutually agreed upon for any work remaining incomplete or uncorrected for which the Owner is entitled a credit under the Contract Documents. If the Design Consultant and the Owner find the Work to be incomplete or unacceptable, the costs of reinspections shall be paid by the Contractor.

Final Payment shall not become due until the Contractor provides to the Design Consultant and Owner: three (3) copies of any of the following required:

Final Change Order

Final Application for Payment

Consent of Surety to Final Payment - AIA G707(if applicable)

Contractor's Affidavit of Release of Liens - AIA G706A

Contractor's Affidavit of Payment of Debts and Claims - AIA G706;

Certificate of Occupancy (if applicable)

Contractor's Warranty, notarized

Warranty Summary Sheet with Original Warranties (if not included in O & M Manuals)

Certification Letter from Contractor that no Asbestos-Containing Materials were used on the project

Final List of Subcontractors (name, address, phone, email, fax nos.)

Record Drawings (As-Built) - 1 set

Operation and Maintenance Manuals - 3 sets & a bookmarked electronic PDF.

Other project close-out submittals, as required by the Contract Documents.

Neither the final payment nor the remaining retained percentage shall become due until the Work is free and clear of any and all liens and the Contractor submits to the Owner:

an affidavit that all payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or his property might in any way be responsible, have been paid or otherwise satisfied;

if required by the Owner, other data establishing payment or satisfaction of all such obligations, such as receipts, releases and waivers of liens arising out of the Contract, to the extent and in such form as may be designated by the Owner; and

As-built drawings, and other project closeout submittals, as required by the Owner.

The making of final payment shall constitute a waiver of all claims by the Owner against the Contractor except those arising from:

unsettled liens, and claims against the Owner or the Design Consultant, or their employees, agents, or representatives,

faulty, defective or non-conforming Work discovered or appearing after Substantial or Final Completion,

failure of the Work to comply with the requirements of the Contract Documents,

terms of any warranties contained in or required by the Contract Documents,

damages incurred by the Owner resulting from lawsuits brought against the Owner, the Design Consultant, or their agents, employees or representatives because of failures or actions on the part of the Contractor, his Subcontractors, Sub-subcontractors, or any of their employees, agents or representatives, or

fraud or bad faith committed by the Contractor or any subcontractor or supplier during performance of work but discovered by Owner after Final Payment.

The acceptance of final payment shall constitute a waiver of all claims by the Contractor except those previously made in writing and identified by the Contractor as unsettled at the time of the final Application for Payment

LIQUIDATED DAMAGES

Should the Contractor fail to substantially complete the Work on or before the date stipulated for Substantial Completion (or such later date as may result from extension of time granted by Owner), he shall pay the Owner, as Substantial Completion liquidated damages the daily amount stated in the Supplementary Conditions for each consecutive calendar day that terms of the contract remain unfulfilled beyond the date allowed by the Contract, which sum is agreed upon as a reasonable and proper measure of damages which the Owner will sustain per day by failure of the Contractor to complete work within time as stipulated; it being recognized by the Owner and the Contractor that the injury to the Owner which could result from a failure of the Contractor to complete on schedule is uncertain and cannot be computed exactly. In no way shall costs for liquidated damages be construed as a penalty on the Contractor.

For each consecutive calendar day that the Work remains incomplete after the date established for Final Completion, the Contractor shall pay or Owner will retain the daily amount stated in the Supplementary Conditions as Final Completion Liquidated Damages from the compensation otherwise to be paid to the Contractor. This amount is the minimum measure of damages the Owner will sustain due to the delay in the completion of all remedial work, the delay in the correction of the deficient work, the disruption to the school and the learning environment, the cost of contract management time and resources, administration time, and the inability to use the facilities fully. This amount is in addition to the liquidated damages prescribed above for Substantial Completion.

The amount of liquidated damages set forth in the corresponding Supplementary Conditions shall be assessed cumulatively. The items of cost included in the assessment of liquidated damages are as defined above. This provision for liquidated damages does not bar Owner's right to enforce other rights and remedies against Contractor, including but not limited to, specific performance or injunctive relief.

OWNER'S RIGHT TO OCCUPY INCOMPLETE WORK

Should the Project, or any portion thereof, be incomplete for Substantial or Final Completion at the scheduled date or dates, the Owner shall have the right to occupy any portion of the Project. In such an event, the Contractor shall not be entitled to any extra compensation on account of said occupancy by the Owner or by the Owner's normal full use of the Project, nor shall the Contractor interfere in any way with said normal full use of the Project. Further, in such an event, the Contractor shall not be entitled to any extra compensation on account of the Owner's occupancy and use of the Project, nor shall the Contractor be relieved of any responsibilities of the Contract including the required times of completion and property insurance coverage, unless specifically altered by the Owner in writing. Such occupancy by the Owner shall not, in itself, constitute Substantial or Final Completion.

END OF ARTICLE 8

ARTICLE 9
INSURANCE AND BONDS

CONTRACTOR'S INSURANCE AND BONDS

The Contractor shall purchase and maintain in companies properly licensed by the Insurance Department of the State of North Carolina and acceptable to the Owner such insurance as will protect him, the Owner, and the Owner's agents, representatives, and employees from claims which may arise out of or result from the Contractor's operations under the Contract, whether such operations be by himself or by any Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable. Such insurance shall include:

Worker's Compensation including Occupational Disease and Employer's Liability Insurance

Statutory - Amount and coverage as required by State of North Carolina Worker's Compensation laws

Employer's Liability

\$1,000,000 Each Accident

\$1,000,000 Policy Limit

\$1,000,000 Each Employee

Commercial General Liability (Occurrence Form) - The Contractor shall provide during the life of this Contract such Commercial General Liability (Occurrence Form) Insurance as shall protect Contractor and any Subcontractor performing work under this Contract from claims for damages for Bodily Injury including accidental death, as well as from claims for Property Damage which may arise from operations under this Contract, whether such operations be by himself or by any Subcontractor or by anyone directly or indirectly employed by either of them. This insurance shall be on the Standard Insurance Services Office, Inc. (ISO) Commercial Liability Occurrence Form. The Contractor shall procure insurance coverage for direct operations, sublet work, elevators, contractual liability and completed operations with limits not less than those stated below:

A Combined Single Limit for Bodily Injury, Property Damage and Personal Injury of:

General Aggregate (except Products - Completed Operations) Limit

Products - Completed Operations Aggregate Limit

Personal and Advertising Injury Limit

Each Occurrence Limit

Property Damages, including Broad Form Property Damage and Explosion, Collapse, Underground property damage coverages, and blasting, where necessary.

Completed Operations Liability: Continuous coverage in force for one year after completion of Work.

Commercial Automobile Insurance, including coverage for owned, non-owned and hired vehicles - with limits not less than a Combined Single Limit for Bodily Injury and Property Damage of \$1,000,000.

Umbrella Liability Insurance: Policy to 'pay on behalf of the Insured' with Limits of Liability: \$1,000,000.

Certificates of Insurance acceptable to the Owner shall be filed with the Owner prior to commencement of the Work. These Certificates shall contain a provision that coverages afforded under the policies will not be canceled until at least thirty (30) days prior written notice has been given to the Owner. Failure to provide such notice shall not limit the liability of the Insurer, its agents or representatives.

All insurance policies required in this Article, except Worker's Compensation and Commercial Automobile, shall name the Owner as additional named insured for the insurance.

Contractor shall not commence work under this Contract until he has obtained all the insurance and bonds required under Article 9 of this Contract and until such insurance and bonds have been approved by the Owner, nor shall Contractor allow any subcontractor to commence work on his subcontract until all similar insurance required of the subcontractor has been so obtained and approved. Approval of the insurance by Owner shall not relieve or decrease the liability of Contractor hereunder.

The Commercial General Liability and Workers Compensation Policies provided by Contractor shall have endorsements waiving subrogation against Owner.

PROPERTY INSURANCE. Contractor shall provide the following property insurance through at least Substantial Completion of the Project:

Unless stated otherwise in the Supplemental Conditions, Contractor shall purchase and at all times maintain such insurance as will protect Contractor, Owner, Subcontractors and Sub-subcontractors from loss or damage to Work or property in the course of construction, including all machinery, materials and supplies on the premises or in transit thereto and intended to become a part of the finished work until Final Completion. This insurance shall be in the form of 'Builder's Risk Covered Cause of Loss Form' to include, but not limited to, theft, collapse, earth movement and flood. Any deductible provision in such insurance shall not exceed \$5,000.00. Notwithstanding any such deductible provision, Contractor shall remain solely liable for the full amount of any item covered by such insurance.

If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion thereof, such occupancy or use shall not commence prior to a time mutually agreed to by Owner and Contractor, and to which the insurance company or companies providing the property insurance have consented by endorsement to the policy or policies. This insurance shall not be canceled or lapsed on account of such partial occupancy or use. Consent of Contractor and of the insurance company or companies to such occupancy or use shall not be unreasonably withheld.

Owner shall be under no obligation to review any Certificates of Insurance provided by Contractor, or to check or verify Contractor's compliance with any and all requirements regarding insurance imposed by the Contract Documents. Contractor is fully liable for the amounts and types of insurance required herein and is not excused should any policy or certificate of insurance provided by Contractor not comply with any and all requirements regarding insurance imposed by the Contract Documents.

All insurance companies providing the above insurance shall be licensed by the Insurance Department of the State of North Carolina and maintain a rating by AM Best or a similar rating company with a minimum of an "A-" rating.

PERFORMANCE AND PAYMENT BONDS

"If required by law, or in the Supplemental Conditions or the Contract Documents, Contractor must provide performance and payment bonds each in the amount of the Contract Sum. Such bonds shall be on forms acceptable to Owner and issued by surety companies licensed to do business in North Carolina and having a rating of at least AM Best "A" rating. Contractor may, at its option, make deposit in the form of certified check with Owner in lieu of the performance and payment bonds in an amount equal to the Contract Sum for each such bond, for a total of 200% of the Contract Sum."

Risk of Loss: Contractor shall bear the risk of loss in the event that any of the Work is stolen, lost, damaged or destroyed prior to the Final Completion of the Work, the issuance of a final Certificate of Occupancy, and acceptance of the Work by the Owner. If any of the Work is stolen, lost, damaged, or destroyed prior to Final Completion, the issuance of a final Certificate of Occupancy, and acceptance of the Work by the Owner, due to any reason except the intentional or reckless acts of Owner or Owner's authorized agents, Contractor shall bear the full cost of repairing or replacing all such Work, including all equipment and materials. Contractor should purchase his own insurance to cover this risk if required by the Contract Documents or otherwise if the Contractor so chooses.

END OF ARTICLE 9

ARTICLE 10

CHANGES IN THE WORK

CHANGE ORDERS/CONSTRUCTION CHANGE DIRECTIVE

The Owner may, at any time, by written order designated or indicated to be a Change Order, make any change or modification in the Work or add to the Work within the general scope of the Contract.

A Change Order is a document executed pursuant to this Article when the Owner and Contractor agree to Changes in the Work, the Contract Sum, the Contract Time and any other change in the Contract by written agreement signed by Owner, Contractor and Design Consultant designated or indicated to be a Change Order. If the Contractor, subsequent to the issuance of a Construction Change Directive, agrees to its terms including any applicable adjustment to the Contract Sum and Contract Time, Contractor shall sign it and it shall become a Change Order.

A Construction Change Directive is a written order prepared by the Design Consultant and signed by the Owner and Design Consultant, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both.

OWNER DIRECTED CHANGES REQUIRING AN INCREASE IN CONTRACT SUM.

If the Change in the Work will result in an increase in the Contract Sum, the Owner shall have the right to require the performance thereof on a lump sum basis, a unit price basis or a time and material basis, all as hereinafter more particularly described (the right of the Owner as aforesaid shall apply with respect to each such Change in the Work).

If the Owner elects to have the Change in the Work performed on a lump sum basis, its election shall be based on a lump sum Proposal which shall be submitted by the Contractor to the Owner within seven (7) days of the Contractor's receipt of a request therefore (but the Owner's request for a lump sum Proposal shall not be deemed an election by the Owner to have the Change in the Work performed on a lump sum basis). The Contractor's Proposal shall be itemized and segregated by labor and materials for the various components of the Change in the Work (no aggregate labor or material total will be acceptable) and shall be accompanied by signed Proposals of any Subcontractors who will perform any portion of the Change in the Work and of any persons who will furnish materials or equipment for incorporation therein. The Proposal shall also include the Contractor's estimate of the time required to perform said changes. The Contractor shall provide any documentation that may be requested by the Owner or Design Consultant to support the change proposal, including but not limited to payroll records, insurance rates, material quotes, and rental quotes. The Change Proposal Forms attached as Appendix B shall be used to submit change proposals on the Project.

The portion of the Proposal relating to labor, whether by the Contractor's forces or the forces of any of its Subcontractors, may include reasonably anticipated gross wages of job site labor, including foremen, who will be directly involved in the Change in the Work (for such time as they will be so involved), plus payroll costs (including premium costs of overtime time, if overtime is anticipated, Social Security, Federal or State unemployment insurance taxes and fringe benefits required by collective bargaining agreements entered into by the Contractor or any such Subcontractor in connection with such labor) and up to fifteen percent (15%) of such anticipated gross wages, but not payroll costs, as overhead and profit for the Contractor or any such

Subcontractor, as applicable (said overhead and profit to include all supervision except foremen). Payroll costs are limited to 39% of the net pay of the worker.

The portion of the Proposal relating to materials may include the reasonably anticipated direct costs to the Contractor or to any of its Subcontractors of materials to be purchased for incorporation in the Change in the Work, plus transportation and applicable sales and use taxes and up to fifteen percent (15%) of said direct material costs as overhead and profit for the Contractor or any such Subcontractor (said overhead and profit to include all small tools), and may further include the Contractor's and any of its Subcontractor's reasonably anticipated rental costs in connection with the Change in the Work (either actual or discounted local published rates), plus up to eight percent (8%) thereof as overhead and profit for the Contractor or any such Subcontractors, as applicable. The Contractor shall provide an itemized breakdown of all transportation and shipping costs, including receipts documenting the expenses. Notwithstanding the above, overhead and profit shall not be applied to any sales tax paid for any purpose or to any transportation or shipping costs incurred by the Contractor or any subcontractor. If any of the items included in the lump sum Proposal are covered by unit prices contained in the Contract Documents, the Owner may, if it requires the Change in the Work to be performed on a lump sum basis, elect to use these unit prices in lieu of the similar items included in the lump sum Proposal, in which event an appropriate deduction will be made in the lump sum amount prior to the application of any allowed overhead and profit percentages. No overhead and profit shall be applied to any unit prices.

The lump sum Proposal may include up to eight percent (8%) of the amount which the Contractor will pay to any of its Subcontractors for Changes in the Work as overhead and profit for the Contractor. The Contractor shall not be reimbursed for the costs of the Subcontractors' Payment and Performance Bonds, as such bonding is not required by the Owner.

In the event that (1) the parties are unable to agree as to the reasonable cost and time to perform the Change in the Work based upon the Contractor's Proposal and the Owner does not elect to have the Change in the Work performed on a time and material basis, (2) the Contractor fails to submit his Proposal within the designated period, or (3) the Work needs to begin immediately, the Owner may choose to make a determination of the reasonable cost and time to perform the Change in the Work, based upon its own estimates, the Contractor's submission or a combination thereof. A Construction Change Directive shall be issued in this case for the amounts of cost and time determined by the Owner and shall become final and binding upon the Contractor, subject to Contractor's right to dispute such action in accordance with Paragraph 10.9. Owner has the right to direct by Construction Change Directive a Change in the Work, which is the subject of such Change Order. Failure of the parties to reach agreement regarding the cost and time of the performing the Construction Change Directive, shall not relieve the Contractor from performing the Change in the Work promptly and expeditiously.

The Owner reserves the right to reject the Contractor's Proposal for a Change in the Work and to elect to perform said Work using a Separate Contractor. Under such circumstances, all provisions of Article 6 shall be in force.

If the Owner elects to have the Change in the Work performed on a time and material basis or on a time and material basis with a not to exceed amount, the same shall be performed, whether by the Contractor's forces or the forces of any of its Subcontractors or Sub-subcontractors, at actual cost to the entity performing the Change in the Work (without any charge for administration, clerical expense, supervision or superintendence of any nature whatsoever, including foremen, or the cost, use or rental of tools or plant), plus fifteen percent (15%) thereof as the total overhead and profit (except that said fifteen percent (15%) shall not be applied against any payroll costs, as set forth in Paragraph 10.2.1.). If the Owner and Contractor agree upon a not to exceed amount, it shall be clearly identified in the Change Order or change proposal form and shall be the maximum amount paid by the Owner for the identified work. The Contractor shall submit to the Owner daily time and material tickets, on a daily basis to include the identification number assigned to the Change in the Work, the location and description of the Change in the Work, the classification of labor employed (and names and social security numbers), the materials used, the equipment rented (not tools) and such other evidence of cost as the Owner may require. The Owner may require authentication of all time and material tickets and invoices by persons designated by the Owner for such purpose. The failure of the Contractor to secure any required authentication shall, if the Owner elects to treat it as such, constitute a waiver by the Contractor of any Claim for the cost of that portion of the Change in the Work covered by a non-authenticated ticket or invoice; provided, however, that the authentication of any such ticket or invoice by the Owner shall not constitute an acknowledgment by the Owner that the items thereon were reasonably required for the Change in the Work.

The Contractor may only bill for all or a portion of work performed on a time and material basis if the work has been completed, accepted and properly documented to the Owner and Design Consultant's satisfaction.

No overhead and profit will be paid by the Owner on account of a Change in the Work except as specifically provided in Section 10.2. Overhead and profit, as allowed under Section 10.2, shall be deemed to include all costs and expenses which the Contractor or any of its Subcontractors may incur in the performance of a Change in the Work and which are not otherwise specifically recoverable by them pursuant to Section 10.2.

CONTRACTOR NOTICE OF CHANGE

If the Contractor or any of its Subcontractors asserts that any event or occurrence has caused a change in or addition to the Work which change causes an increase or decrease in the Contractor's or its Subcontractors' cost or the time required for the performance of any part of the Work under the Contract, including Work not affected directly by the change, the Contractor shall, within ten (10) days of such event, give the Owner written notice as herein required. Said notice shall include the instructions or circumstances that are the basis of the claim and the Contractor's best estimate of the cost and time involved.

If the Contractor intends to assert a claim under this Article, he must, within ten (10) days after receipt of a written Change Directive under Subparagraph 10.2.1 above or the furnishing of a written notice under Subparagraph 10.3.1, submit to the Owner a written statement setting forth the specific nature and cost of such claim, unless this period is extended by the Owner. The statement of claim hereunder may be included in the notice under Subparagraph 10.3.1 above. The statement of claim shall include all direct, indirect and impact costs associated with the change, as well as the Contractor's estimate of the schedule impact of the

change, if any. The Contractor and its subcontractors shall not be entitled to reimbursement for any claims that are not filed in strict conformance with this Article. The Contractor shall indemnify and hold the Owner harmless against any claims by Subcontractors that are waived because they are not filed in strict conformance with this Article.

If the parties are unable to agree to the reasonable cost and time to perform the Change, or are unable to agree as to whether a change occurred, the Owner shall make a unilateral determination as described in Article 10.2.2. The Contractor shall proceed pursuant to the provisions of that Article.

GENERAL PROVISIONS RELATED TO CHANGES

The Contractor shall not be entitled to any amount for indirect costs, damages or expenses of any nature, including, but not limited to, so-called "impact" costs, labor inefficiency, wage, material or other escalations beyond the prices upon which the proposal is based and to which the parties have agreed pursuant to the provisions of Article 10, and which the Contractor, its Subcontractors or Sub-subcontractors or any other person may incur as a result of delays, interferences, suspensions, changes in sequence or the like, for whatever cause, whether reasonable or unreasonable, foreseeable or unforeseeable, or avoidable or unavoidable, arising from the performance of any and all changes in the Work performed pursuant to this Article 10, unless the delay is caused solely by the Owner or its agent. It is understood and agreed that the Contractor's sole and exclusive remedy in such event shall be recovery of his direct costs as compensable hereunder and an extension of the Contract Time, but only in accordance with the provisions of the Contract Documents. The phrase "Owner or its agent" as used in this Agreement, does not include the Prime Contractors or their Subcontractors.

No claim by the Contractor hereunder shall be allowed if asserted after final payment under this Contract. No claim relating to or flowing from a particular change shall be allowed after execution of the Change Order relating to that change or commencement of the change by the Contractor.

CHANGES REQUIRING A DECREASE IN CONTRACT SUM.

If the Change in the Work will result in a decrease in the Contract Sum, the Owner may request a quotation by the Contractor of the amount of such decrease for use in preparing a Change Order. The Contractor's quotation shall be forwarded to the Owner within ten (10) days of the Owner's request and, if acceptable to the Owner, shall be incorporated in the Change Order. If not acceptable, the parties shall make every reasonable effort to agree as to the amount of such decrease, which may be based on a lump sum properly itemized, on unit prices stated in the Contract Documents and/or on such other basis as the parties may mutually determine. If the parties are unable to so agree, the amount of such decrease shall be the total of the estimated reduction in actual cost of the Work, as determined by the Owner in its reasonable judgment, plus fifteen percent (15%) thereof as overhead and profit.

DISPUTES REGARDING CHANGES.

If any dispute should arise between the parties with respect to an increase or decrease in the Contract Sum or an expansion or contraction in the Contract Time as a result of a Change in the Work, the Contractor shall

not suspend performance of a Change in the Work or the Work itself unless otherwise so ordered by the Owner in writing. The Owner shall, however, pay to the Contractor up to the Owner's reasonable estimated value of the Change in the Work, regardless of the dispute, if said Change in the Work results in an increase in the Contract Sum; and the Owner shall have the right to decrease the Contract Sum up to the Owner's reasonable estimated value of the Change in the Work, regardless of the dispute, if said Change in the Work results in a decrease in the Contract Sum.

MINOR CHANGES IN THE WORK

The Owner shall have authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time and not inconsistent with the intent of the Contract Documents. Such changes shall be effected by written order, and shall be binding on the Owner and the Contractor. The Contractor shall carry out such written orders promptly.

The Contractor shall not perform any changes in the Work unless authorized in writing by the Design Consultant or Owner.

DIFFERING SITE CONDITIONS

Should the Contractor encounter subsurface and/or latent conditions at the site materially differing from those shown on the drawings or indicated in the specifications or differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in this contract, he shall immediately give notice to the Owner of such conditions before they are disturbed. The Owner and the Design Consultant shall thereupon promptly investigate the conditions and if they find that they materially differ from those shown on the drawings or indicated in the specifications, they shall at once make such changes in the drawings and/or specifications as they may find necessary. Any increase or decrease of cost resulting from such changes shall be adjusted in the manner provided herein for adjustments as to extra and/or additional work and changes. However, neither the Owner nor the Design Consultant shall be liable or responsible for additional work, costs or changes to the work due to material differences between actual conditions and any geotechnical, soils and other reports, surveys and analyses made available for the Contractor's review.

CLAIMS AND DISPUTE RESOLUTION

Definition. A Claim is a demand or assertion by the Contractor seeking, as a matter of right, adjustment or interpretation of Contract terms, payment of money, extension of time or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question from the Contractor arising out of or relating to the Contract. Claims must be initiated by written notice. The responsibility to substantiate Claims shall rest with the Contractor.

Time Limits on Claims. Claims by Contractor must be initiated within 10 days occurrence of the event giving rise to such Claim or within 10 days after the Contractor first recognizes the condition giving rise to the

Claim, whichever is later, but in no event subsequent to the Contractor's final payment application. Claims must be initiated by written notice to the Design Consultant (if there is one) and the other party.

Continuing Contract Performance. Pending final resolution of a Claim except as otherwise agreed in writing or as otherwise provided in the Contract Documents, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make undisputed payments in accordance with the Contract Documents.

Claims for Additional Cost. If the Contractor wishes to make 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 when the giving of such notice would increase the risk of injury or damage to persons or property.

Claims for Additional Time. If the Contractor wishes to make Claim for an extension of the dates set for Substantial or Final Completion, 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. Contractor bears the burden of proving it is entitled to an extension of time. Unless Contractor meets this burden, Liquidated Damages shall be assessed automatically.

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 relevant period of time, could not have been reasonably anticipated and had an adverse effect on the scheduled construction.

Resolution of Claims and Disputes. Claims, including those alleging an error or omission by the Design Consultant, shall be referred initially to the Design Consultant for decision, if there is a Design Consultant with Contract Administration duties which include Claims resolution; otherwise, such Claims by Contractor shall initially be referred to the Owner. An initial decision by such Design Consultant (or Owner as applicable) shall be required as a condition precedent to mediation or litigation of all Claims by the Contractor arising prior to the date final payment is due, unless 30 days have passed after the Claim has been referred to the Design Consultant (or Owner as applicable) with no decision having been rendered. The Design Consultant (or Owner as applicable) will not decide disputes between the Contractor and persons or entities other than the Owner.

The Design Consultant (or Owner as applicable) will review Claims and within ten days of the receipt of the Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Design Consultant is unable to resolve the Claim if the Design Consultant lacks sufficient information to evaluate the merits of the Claim or if the Design Consultant concludes that, in the Design Consultant's sole discretion, it would be inappropriate for the Design Consultant to resolve the Claim.

Upon receipt of the response or supporting data, if any, the Design Consultant (or Owner as applicable) will either reject or approve the Claim in whole or in part.

The Design Consultant (or Owner as applicable) will approve or reject Claims by written decision, which shall state the reasons therefor and which shall notify the parties or any change in the Contract Sum or Contract Time, or both. The approval or rejection of a Claim by the Design Consultant (or Owner as applicable) shall be final and binding on the parties but subject to mediation and litigation.

When a written decision of the Design Consultant (or Owner as applicable) states that (1) the decision is final but subject to mediation and litigation and (2) a demand for mediation of a Claim (if required by Owner's Dispute Resolution Procedures) or the commencement of a lawsuit (if mediation is not required as a pre-condition to litigation in Owner's Dispute Resolution Procedures) covered by such decision must be made or done within 30 days after the date on which the party making the demand (or filing the lawsuit) receives the final written decision, then failure to demand mediation in writing (if required) or file the lawsuit within said 30 days' period shall result in the Design Consultant's (or Owner's as applicable) decision becoming final and binding upon the Owner and Contractor. If the Design Consultant (or Owner as applicable) renders a decision after litigation proceedings have been initiated, such decision may be entered as evidence, but shall not supersede litigation proceedings unless the decision is acceptable to all parties concerned.

In the event of a dispute, the Owner, Contractor, and other parties involved in the Project shall utilize the Dispute Resolution Procedures adopted by Owner pursuant to N.C.G.S. §143-128(g), if applicable. Owner's Dispute Resolution Procedures are as follows:

These Procedures are applicable to the resolution of disputes with amounts in controversy in excess of \$15,000.00 arising between or among any parties involved in Owner's construction and repair Projects, including the Design Consultant and the Contractors, and the first and lower tier subcontractors, on Claims arising out of the contract or construction process. In no event shall the Owner be subject to arbitration proceedings pursuant to these Procedures. Unless otherwise specified in these Procedures, if there is any conflict between these Procedures and the other provisions of the Contract Documents, the terms of these Procedures control.

Any Claim as defined in the Contract Documents or any dispute between parties to a construction contract involving the Project, other than the Owner's claims, except those Claims which are waived shall be subject to nonbinding mediation as a condition precedent to the institution of legal proceedings by any party, except that any party may institute legal proceedings in order to meet any applicable statute of limitations or similar deadlines prior to engaging in nonbinding mediation.

The parties shall endeavor to resolve their claims by nonbinding mediation, which, unless the parties mutually agree otherwise, shall be in accordance with rules established by Owner if Owner is a party to the mediation. If Owner is not a party to the mediation, the mediation shall be conducted in accordance with rules established by the parties to the mediation. The parties to the mediation shall share the cost of mediation equally. The mediation shall be held in the place where the project is located unless another

location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

All suits in law or equity between the Owner and the Contractor arising out of the Contract shall be heard in the appropriate court of justice in the county where the Project is located.

END OF ARTICLE 10

ARTICLE 11

CORRECTION OF WORK

CORRECTION OF WORK

The Contractor shall promptly reconstruct, replace or correct all Work rejected by the Design Consultant as defective or as failing to conform to the Contract Documents or as not in accordance with the guarantees and warranties specified in the Contract Documents whether observed before or after Substantial Completion and whether or not fabricated, installed or completed. The Contractor shall bear all costs of correcting such rejected Work, including compensation for the Design Consultant's and the Owner's additional construction management services made necessary thereby.

The Contractor, unless removal is waived by the Owner, shall remove from the site all portions of the Work which are defective or non-conforming, or if permitted or required, he shall correct such work in place at his own expense promptly after receipt of notice, and such rejected Work shall not thereafter be tendered for acceptance unless the former rejection or requirement for correction is disclosed.

If the Contractor does not proceed with the correction of such defective or non-conforming Work within a reasonable time fixed by written notice from the Owner, the Owner may either (1) by separate contract or otherwise replace or correct such Work and charge the Contractor the cost occasioned the Owner thereby and remove and store the materials or equipment at the expense of the Contractor, or (2) terminate this Contract for default as provided in Paragraph 12.3. If the Contractor does not pay the cost of such replacement or correction and the removal and storage within ten (10) days thereafter, the Owner may upon ten (10) additional days' written notice sell such Work at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs that should have been borne by the Contractor, including compensation for additional services of the Design Consultant and the Owner made necessary thereby. If such proceeds of sale do not cover all costs, which the Contractor should have borne, the difference shall be charged to the Contractor and an appropriate Change Order shall be issued. If the payments then or thereafter due the Contractor are not sufficient to cover such amount, the Contractor shall pay the difference

to the Owner.

The Contractor shall bear the cost of making good all work of the Owner or separate contractors destroyed or damaged by such correction or removal.

Nothing contained in this Paragraph 11.1 shall be construed to establish a period of limitation with respect to any other obligation, which the Contractor might have under the Contract Documents, including Paragraph 3.5 hereof. The establishment of the time period of one year after the Date of Substantial Completion or such longer period of time as may be prescribed by law or by the terms of any warranty required by the Contract Documents relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which his 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 his obligations other than specifically to correct the Work.

END OF ARTICLE 11

ARTICLE 12

TERMINATION OF THE CONTRACT

TERMINATION BY THE CONTRACTOR

If the Work is stopped for a period of sixty (60) days under an order of any court or other public authority having jurisdiction, or as a result of an act of government, such as a declaration of a national emergency making materials unavailable, through no act or fault of the Contractor or a Subcontractor or their agents or employees or any other persons performing any of the Work under a contract with the Contractor, then the Contractor may, upon seven (7) additional days' written notice to the Owner and the Design Consultant, terminate the Contract and recover from the Owner payment on a quantum meruit basis, for all Work executed. The Contractor shall not be entitled to collect and hereby expressly waives, any profit on work not performed or any damages related to that portion of the Contract, which has been terminated.

TERMINATION FOR CONVENIENCE OF THE OWNER

The Owner may, at any time upon ten (10) days' written notice to the Contractor which notice shall specify that portion of the Work to be terminated and the date said termination is to take effect, terminate (without prejudice to any right or remedy of the Owner) the whole or any portion of the work for the convenience of the Owner. The Contractor's sole remedy, in the event of such termination, will be the allowable termination costs permitted by Article 12.4. Contractor shall include termination clauses identical to Article 12 in each of his Subcontracts.

DEFAULT TERMINATION

Subject to the provisions of Paragraph 2.3.1, ten (10) days after written notice is mailed to the Contractor, the Owner may terminate (without prejudice to any right or remedy of the Owner or any subsequent buyer of any portion of the Work) the employment of the Contractor and his right to proceed either as to the whole or any portion of the Work required by the Contract Documents and may take possession of the Work and complete the Work by contract or otherwise in any one of the following circumstances:

if the Contractor refuses or fails to prosecute the work or any separable part thereof with such diligence as will ensure the Substantial or Final Completion of the Work within the Contract Time or fails to complete the Work or remedy a default within said period;

if the Contractor is in material default in carrying out any provisions of the Contract for a cause within his control;

if the Contractor fails to supply a sufficient number of properly skilled workmen or proper equipment or materials;

if the Contractor fails to make prompt payment to Subcontractors or for materials or labor, unless he otherwise provides the Owner satisfactory evidence that payment is not legally due;

if the Contractor disregards laws, permits, ordinances, rules, regulations or orders of any public authority having jurisdiction, or fails to follow the instructions of the Owner;

if the Contractor substantially violates any provisions of the Contract Documents; or

if the Contractor refuses or fails to properly schedule, plan, coordinate and execute the Work, as specified herein, so as to perform the Work within the specified Milestone and Completion dates, or to provide scheduling or related information, revisions and updates as required by the Contract Documents.

If, after the Contractor has been terminated for default pursuant to Paragraph 12.3, it is determined that none of the circumstances set forth in Subparagraph 12.3.1 exist, then such termination shall be considered a termination for convenience pursuant to Paragraph 12.2 In such case, the Contractor's sole remedy will be the costs permitted by Article 12.4.

If the Owner so terminates the employment of the Contractor, the Contractor shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the compensation is to be paid to the Contractor hereunder shall exceed the expense of so completing the Work (including compensation for additional managerial, administrative, consultant and inspection services and any damages for delay) such excess shall be paid to the Contractor.

If such expenses shall exceed the unpaid balance, the Contractor shall be liable to the Owner for such excess. If the right of the Contractor to proceed with the Work is partially or fully terminated, the Owner may take possession of and utilize in completing the Work such materials, appliances, supplies, plant and equipment as may be on the site of the terminated portion of the Work and necessary for the completion of the Work. If the Owner does not fully terminate the right of the Contractor to proceed, the Contractor shall continue to perform the part of the work that is not terminated.

ALLOWABLE TERMINATION COSTS

If the Owner terminates the whole or any portion of the Work pursuant to Paragraph 12.2, then the Owner shall only be liable to the Contractor for those costs reimbursable to the Contractor in accordance with Subparagraph 12.4.2, plus a markup of ten percent for profit and overhead on the actual fully accounted costs recovered under 12.4.2; provided however, that if there is evidence that the Contractor would have sustained a loss on the entire Contract had it been completed, no profit shall be included or allowed hereunder and an appropriate adjustment shall be made reducing the amount of the settlement to reflect the indicated rate of loss.

After receipt of a Notice of Termination, the Contractor shall submit to the Owner his termination claim, in the form and with certification prescribed by the Owner. Such claim shall be submitted promptly but in no event later than three (3) months from the effective date of termination, unless one or more extensions in writing are granted by the Owner upon request of the Contractor made in writing within such three (3) month period or authorized extension thereof. However, if the Owner determines that the facts justify such action, he may receive and evaluate any such termination claim at any time after such three (3) month period or any extension thereof. Upon failure of the Contractor to submit his termination claim within the time allowed, the Owner may determine, on the basis of information available to him, the amount, if any, due to the Contractor by reason of the termination.

If the Owner terminates the whole or any portion of the Work pursuant to Paragraph 12.2, the Owner shall pay the Contractor the amounts determined by the Owner as follows:

an amount for supplies, services, or property accepted by the Owner pursuant to Clause 12.5.1.6 or sold or acquired pursuant to Clause 12.5.1.7 and not heretofore paid for, and to the extent provided in the Contract such amount shall be equivalent to the aggregate price for such supplies or services computed in accordance with the price or prices specified in the Contract, appropriately adjusted for any saving of freight or other charges; and

the total of:

the cost incurred in the performance of the Work terminated, including initial costs and preparatory expense allocable thereto, but exclusive of any costs attributable to supplies or services paid or to be paid for under Clauses 12.4.2.1 or 12.4.2.2.(2);

the cost of settling and paying claims arising out of the termination of Work under Subcontracts or orders, pursuant to Clause 12.5.1.5, which are properly chargeable to the terminated portion of the Work (exclusive of amounts paid or payable on account of completed items of equipment delivered or services furnished by Subcontractors or vendors prior to the effective date of the notice of termination), which amounts shall be included in the costs payable under (1) above; and

the reasonable costs of settlement, including accounting, legal, clerical and other expenses reasonably necessary for the preparation of settlement claims and supporting data with respect to the terminated portion of the Work and for the termination and settlement of Subcontracts thereunder, together with reasonable storage, transportation and other costs incurred in connection with the protection or disposition of property allocable to the Contract.

Provided, however, that neither the Owner nor the Design Consultant will be liable for payments to Subcontractors pursuant to Article 12.4.2.2 unless each subcontract contains termination provisions identical to those set forth in Article 12. The Owner and the Design Consultant will not be liable to the Contractor for any costs associated with termination if the subcontract of the party involved does not include the proper termination clauses.

In arriving at any amount due the Contractor pursuant to Paragraph 12.4, there shall be deducted the following:

all unliquidated advance or other payments on account theretofore made to the Contractor applicable to the terminated portion of the Contract;

any claim which the Owner may have against the Contractor;

such amount as the Owner determines to be necessary to protect the Owner against loss because of outstanding or potential liens or claims; and

the agreed price for, or the proceeds of sale of, any materials, supplies or other things acquired by the Contractor or sold, pursuant to the provisions of Clause 12.5.1.7, and not otherwise recovered by or credited to the Owner.

The total sum to be paid to the Contractor under Paragraph 12.4 shall not exceed the Contract Sum as reduced by the amount of payments otherwise made or to be made for Work not terminated and as otherwise permitted by the Contract. Except for normal spoilage, and except to the extent that the Owner shall have otherwise expressly assumed the risk of loss, there shall be excluded from the amounts payable to the Contractor, as provided in Subparagraph 12.4.2, the fair value, as determined by the Owner, of property which is destroyed, lost, stolen or damaged so as to become undeliverable to the Owner, or to a buyer pursuant to Clause 12.5.1.7.

If the Owner terminates the whole or any part of the Work pursuant to Paragraph 12.3, the Owner may procure, upon such terms and in such manner as the Owner may deem appropriate, supplies or services similar to those so terminated, and the Contractor shall be liable to the Owner for any excess costs for such similar supplies or services. The Contractor shall continue the performance of the Contract to the extent not terminated hereunder.

GENERAL TERMINATION PROVISIONS

After receipt of a notice of termination from the Owner, pursuant to Paragraph 12.2 or 12.3, and except as otherwise directed by the Owner, the Contractor shall:

stop Work under the Contract on the date and to the extent specified in the notice of termination;

place no further orders or subcontracts for materials, services or facilities, except as may be necessary for completion of such portion of the work under the Contract as is not terminated;

terminate all orders and subcontracts to the extent that they relate to the performance of Work terminated by the notice of termination;

at the option of the Owner, assign to the Owner in the manner, at the times and to the extent directed by the Owner, all of the rights in the contracts so terminated, in which case the Owner shall have the right, at his discretion, to settle or pay any or all claims arising out of the termination of such orders and subcontracts;

settle all outstanding liabilities and all claims arising out of such termination or orders and subcontracts, with the approval or ratification of the Owner, to the extent he may require, which approval or ratification shall be final for all the purposes of this Article;

transfer title and deliver to the entity or entities designated by the Owner, in the manner, at the times and to the extent directed by the Owner to the extent specifically produced or specifically acquired by the Contractor for the performance of such portion of the Work as had been terminated, the following:

the fabricated or unfabricated parts, Work in process, partially completed supplies and equipment, materials, parts, tools, dies, jigs and other fixtures, completed Work, supplies and other material produced as part of, or acquired in connection with the performance of, the Work terminated by the notice of termination; and

the completed or partially completed plans, drawings, information, releases, manuals and other property related to the Work and which, if the Contract had been completed, would have been required to be furnished to the Owner;

use his best efforts to sell, in the manner, at the times, to the extent and at the price or prices directed or authorized by the Owner, any property of the types referred to in Clause 12.5.1.6; provided, however, that the Contractor:

shall not be required to extend credit to any buyer, and

may acquire any such property under the conditions prescribed by and at a price or prices approved by the Owner; and provided further that the proceeds of any such transfer or disposition shall be applied in reduction of any payments to be made by the Owner to the Contractor under the Contract or shall otherwise

be credited to the Contract Sum covered by the Contract or paid in such other manner as the Owner may direct;

complete performance of such part of the Work as shall not have been terminated by the notice of termination; and

take such action as may be necessary, or as the Owner may direct, for the protection and preservation of the property related to the Contract, which is in the possession of the Contractor, and in which the Owner has or may acquire an interest.

The Contractor shall, from the effective date of termination until the expiration of three (3) years after final settlement under the Contract, preserve and make available to the Owner, at all reasonable times at the office of the Contractor, but without direct charge to the Owner, all his books, records, documents and other evidence bearing on the costs and expenses of the Contractor under the Contract and relating to the Work terminated hereunder, or, to the extent approved by the Owner, photographs, micro-photographs or other authentic reproductions thereof.

If the termination, pursuant to Paragraph 12.2, be partial, the Contractor may file with the Owner a claim for an equitable adjustment of the price or prices specified in the Contract relating to the continued portion of the Contract (the portion not terminated by the notice of termination), and such equitable adjustment as may be agreed upon shall be made in such price or prices. Any claim by the Contractor for an equitable adjustment under this Subparagraph must be asserted within six (6) months from the effective date of the notice of termination.

The Contractor shall refund to the Owner any amounts paid by the Owner to the Contractor in excess of costs reimbursable under Paragraph 12.4.

The Contractor shall be entitled to only those damages and that relief from termination by the Owner as specifically provided in Article 12.

END OF ARTICLE 12

ARTICLE 13

FEDERALLY FUNDED PROJECTS

The Contractor is notified that this project will be financed with federal funds. The Contractor shall ensure that all subcontracts and other contracts for goods and services for this project have the below provisions of this section their contracts. Contractor agrees to comply with the following provisions. Failure to comply with

any and all provisions herein may be cause for the Owner to issue a cancellation notice to the Contractor.

REMEDIES FOR BREACH.

The Owner reserves all rights and privileges under the applicable laws and regulations with respect to this Agreement in the event of breach of contract by either party.

TERMINATION FOR CAUSE AND FOR CONVENIENCE BY OWNER.

The Owner reserves the right to immediately terminate this Agreement in the event of a breach or default of the agreement by Contractor, in the event Contractor fails to: (1) meet schedules, deadlines, and/or delivery dates within the time specified by this Agreement and/or an IPPA; (2) make any payments owed; or (3) otherwise perform in accordance with the Agreement and/or the IPPA. The Owner also reserves the right to terminate the Agreement immediately, with written notice to Contractor, for convenience, if the Owner believes, in its sole discretion that it is in the best interest of the Owner to do so. The Contractor will be compensated for work performed and accepted and goods accepted by the Owner as of the termination date if the Agreement is terminated for convenience of the Owner. The award of this Agreement is not exclusive and the Owner reserves the right to purchase goods and services from other vendors when it is in the best interest of the Owner.

EQUAL EMPLOYMENT OPPORTUNITY.

Except as otherwise provided under 41 CFR Part 60, when funds will be expended by the Owner pursuant to this Agreement that meet the definition of "federally assisted construction contract" in 41 CFR Part 60-1.3, Contractor certifies it will comply with the equal opportunity clause provided under 41 CFR 60-1.4(b), in accordance with Executive Order 11246, "Equal Employment Opportunity" (30 FR 12319, 12935, 3 CFR Part, 1964-1965 Comp., p. 339), as amended by Executive Order 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," and implementing regulations at 41 CFR part 60, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor."

DAVIS-BACON ACT, AS AMENDED (40 U.S.C. 3141-3148).

During the term of this Agreement, including any IPPAs issued pursuant to this Agreement, the Contractor certifies it will be in compliance with all applicable Davis-Bacon Act provisions. In accordance with the statute, Contractor shall pay wages to laborers and mechanics at a rate not less than the prevailing wages specified in a wage determination made by the Secretary of Labor. In addition, the Contractor shall pay wages not less than once a week, unless employees voluntarily agree to a different schedule. The Owner will report all suspected or reported violations to the Federal awarding agency. Contractor certifies it will comply with the Copeland "Anti-Kickback" Act (40 U.S.C. 3145), as supplemented by Department of Labor regulations (29 CFR Part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States"). The Act provides that each vendor or subrecipient must be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation to which he or she is otherwise entitled. The Owner will report all suspected or reported violations to the Federal awarding agency.

CONTRACT WORK HOURS AND SAFETY STANDARDS ACT (40 U.S.C. 3701-3708).

The Contractor certifies that during the term of an award for all contracts in excess of \$100,000 that involve the employment of mechanics or laborers, the Contractor will be in compliance with all applicable provisions of the Contract Work Hours and Safety Standards Act. Under 40 U.S.C. 3702 of the Act, each vendor must be required to compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than one and a half times the basic rate of pay for all hours worked in excess of 40 hours in the work week. The requirements of 40 U.S.C. 3704 are applicable to construction work and provide that no laborer or mechanic must be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.

RIGHTS TO INVENTIONS MADE UNDER A CONTRACT OR AGREEMENT.

If the Federal award meets the definition of "funding agreement" under 37 CFR §401.2 (a) and Contractor wishes to enter into a contract with a small business firm or nonprofit organization regarding the substitution of parties, assignment or performance of experimental, developmental, or research work under that "funding agreement," Contractor agrees to comply with the requirements of 37 CFR Part 401, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," and any implementing regulations issued by the awarding agency.

CLEAN AIR ACT (42 U.S.C. 7401-7671Q.) AND THE FEDERAL WATER POLLUTION CONTROL ACT (33 U.S.C. 1251-1387) COMPLIANCE.

The Contractor certifies that during the term of an award for all contracts by the Owner associated with this Agreement in excess of \$150,000, the Contractor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401-7671q) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251- 1387). Violations must be reported to the Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA).

DEBARMENT AND SUSPENSION.

Contractor certifies that during the term of an award for all contracts by the Owner associated with this Agreement, the Contractor certifies that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation by any federal department or agency.

COMPLIANCE WITH BYRD ANTI-LOBBYING AMENDMENT (31 U.S.C. 1352).

When federal funds are expended by the Owner for a contract exceeding \$100,000, the Contractor certifies that during the term and after the awarded term of all contracts by the Owner associated with this Agreement, the Contractor certifies that it is in compliance with all applicable provisions of the Byrd Anti-Lobbying Amendment (31 U.S.C. 1352). The Contractor further certifies that:

No Federal appropriated funds have been paid or will be paid for on behalf of the Contractor, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of congress, or an employee of a Member of Congress in connection with the awarding of a Federal contract, the making of a Federal grant, the making of a Federal loan, the entering into a cooperative agreement, and the extension, continuation, renewal, amendment, or modification of a Federal contract, grant, loan, or cooperative agreement.

If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of congress, or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying", in accordance with its instructions.

The Contractor shall require that the language of this certification be included in the award documents for all covered sub-awards exceeding \$100,000 in Federal funds at all appropriate tiers and that all subrecipients shall certify and disclose accordingly.

COMPLIANCE WITH SOLID WASTE DISPOSAL ACT.

In the event the Agreement involves the purchase of more than \$10,000 in items designed by guidelines of the Environmental Protection Agency at 40 C.F.R. Part 247, Contractor agrees to comply with the requirements of section 6002 of the Solid Waste Disposal Act. In particular, the Contractor certifies that the percentage of recovered materials to be used in the performance of the Agreement will be at least the amount required by applicable specifications or other contractual requirements.

PROHIBITION ON CERTAIN TELECOMMUNICATIONS AND VIDEO SURVEILLANCE SERVICES OR EQUIPMENT.

As detailed in 2 CFR § 200.216, Contractor certifies that any equipment, services, or systems provided through this Agreement shall not use covered telecommunications equipment or services as a substantial or essential component of a system or as part of any system.

DOMESTIC PREFERENCE.

As detailed in 2 CFR § 200.322, as appropriate and to the extent consistent with law, Contractor certifies that, to the greatest extent practicable, the goods, products, or materials furnished through this award will be produced in the United States (including but not limited to iron, aluminum, steel, cement, and other manufactured products).

RECORDS RETENTION REQUIREMENTS.

The Contractor certifies that it will comply with the record retention requirements detailed in 2 CFR § 200.334. The Contractor further certifies that Contractor will retain all records as required by 2 CFR § 200.334 for a period of three years after grantees or subgrantees submit final expenditure reports or quarterly or annual financial reports, as applicable, and all other pending matters are closed.

CERTIFICATION OF NON-COLLUSION STATEMENT.

Contractor certifies under penalty of perjury that its response to this procurement solicitation is in all respects bona fide, fair, and made without collusion or fraud with any person, joint venture, partnership, corporation or other business or legal entity.

PROHIBITION ON GIFTS.

Contractor certifies that it will comply with the prohibition against giving gifts, gratuities, favors or anything of monetary value to an officer, employee or agent of the School System. Contractor understands and agrees that violation of these standards will result in termination of the Agreement and may result in ineligibility for future contract awards.

In witness whereof, each individual executing this agreement acknowledges that he/she/it is authorized to execute this agreement on behalf of his/her/its principle and further acknowledges the execution of this agreement the day and year first written above.

END OF ARTICLE 13

END OF GENERAL CONDITIONS

Supplementary General Conditions

TIME OF COMPLETION

The Contractor shall commence work to be performed under this Contract on a date to be specified in written order from the Designer/Owner and shall fully complete all work hereunder within four hundred thirteen (413)—consecutive calendar days from the Notice to Proceed (expected to be June 15, 2023) with Completion by August 1, 2024 (Completion dates are based on 413 calendar days after NTP, dates are subject to change dependent on issue date of the NTP). For each day in excess of the above number of days, the Contractor shall pay the Owner the amount of two hundred and fifty Dollars (\$250) as liquidated damages reasonably estimated in advance to cover the losses to be incurred by the Owner should the Contractor fail to complete the Work within the time specified.

If the Contractor is delayed at any time in the progress of his work by any act or negligence of the Owner, his employees or his separate contractor, by changes ordered in the work; by abnormal weather conditions; by any causes beyond the Contractor's control or by other causes deemed justifiable by Owner, then the contract time may be reasonably extended in a written order from the Owner upon written request from the contractor within ten days following the cause for delay. Time extensions for weather delays, acts of God, labor disputes, fire, delays in transportation, unavoidable casualties or other delays which are beyond the control of the Owner do not entitle the Contractor to compensable damages for delays. Any contractor claim for compensable damages for delays is limited to delays caused solely by the owner or its agents.

PRE-BID CONFERENCE:

Meeting: On May 8, 2023 at 11:00am, a MANDATORY Pre-bid meeting will be held at G.W. Bulluck Elementary School for all interested parties.

CONSTRUCTION SCHEDULE:

The Contractor shall commence work to be performed under this Contract on a date to be specified in written order from the Designer/Owner and shall fully complete all work hereunder within four hundred thirteen (413)—consecutive calendar days from the Notice to Proceed (expected to be June 15, 2023) with Completion by August 1, 2024 (Completion dates are based on 413 calendar days after NTP, dates are subject to change dependent on issue date of the NTP). For each day in excess of the above number of days, the Contractor shall pay the Owner the amount of two hundred and fifty Dollars (\$250) as liquidated damages reasonably estimated in advance to cover the losses to be incurred by the Owner should the Contractor fail to complete the Work within the time specified.

Existing equipment shall not be demolished until new equipment has guaranteed ship dates and/or is already on site or in a bonded warehouse.

Contractors are allowed to work during Normal Hours anytime the students are not in school. Anytime the students are in school the contractors shall work hours that will not interfere with the normal student day.

PROJECT STORAGE:

The contractor must store equipment in a bonded warehouse prior to installation.

PAYMENTS:

The Owner will use e-procurement for all payments to be made to the contractor. The contractor shall carry any fees required in his bid. The Owner will make two payments at the beginning of the shutdown after material is onsite and after final inspection and close-out material is provided and accepted.

UTILITIES:

Contractor may use existing utilities and facilities at no additional costs. Owner will provide multiple parking spaces at building..

USE OF SITE:

Refer to time of completion for work schedule information.

NO SMOKING POLICY:

The building is non-smoking. See smoking locations on door decals at egress doors.

BID BOND:

Contractor shall furnish a Bid Bond. Each proposal shall be accompanied by a cash deposit or a certified check drawn on some bank or trust company insured by the Federal Deposit Insurance Corporation, or a bid bond in an amount equal to not less than five percent (5%) of the proposal, said deposit to be retained by the owner as liquidated damages in event of failure of the successful bidder to execute the contract within ten (10) days after the award or to give satisfactory surety as required by law (G.S. 143-129).

Bid bond shall be conditioned that the surety will, upon demand, forthwith make payment to the obligee upon said bond if the bidder fails to execute the contract. The owner may retain bid securities of any bidder(s) who may have a reasonable chance of award of contract for the full duration of time stated in the Notice to Bidders. Other bid securities may be released sooner, at the discretion of the owner. All bid securities (cash or certified checks) shall be returned to the bidders promptly after award of contracts, and no later than seven (7) days after expiration of the holding period stated in the Notice to Bidders.

PERFORMANCE AND PAYMENT BONDS:

Contractor shall furnish a Performance Bond and Payment Bond executed by a surety company authorized to do business in North Carolina. The bonds shall be in the full contract amount. Bonds shall be executed in the form bound with these specifications (Forms 307 & 308). An authorized agent of the bonding company who is licensed to do business in North Carolina shall countersign all bonds.

MINORITY BUSINESS PARTICIPATION:

Refer to attached Minority Business Employment Requirements.

END OF SECTION 00 73 00

GUIDELINES FOR RECRUITMENT AND SELECTION OF MINORITY BUSINESSES FOR PARTICIPATION IN STATE CONSTRUCTION CONTRACTS

In accordance with G.S. 143-128.2 (effective January 1, 2002) these guidelines establish goals for minority participation in single-prime bidding, separate-prime bidding, construction manager at risk, and alternative contracting methods, on State construction projects in the amount of \$300,000 or more. The legislation provides that the State shall have a verifiable ten percent (10%) goal for participation by minority businesses in the total value of work for each project for which a contract or contracts are awarded. These requirements are published to accomplish that end.

SECTION A: INTENT

It is the intent of these guidelines that the State of North Carolina, as awarding authority for construction projects, and the contractors and subcontractors performing the construction contracts awarded shall cooperate and in good faith do all things legal, proper and reasonable to achieve the statutory goal of ten percent (10%) for participation by minority businesses in each construction project as mandated by GS 143-128.2. Nothing in these guidelines shall be construed to require contractors or awarding authorities to award contracts or subcontracts to or to make purchases of materials or equipment from minority-business contractors or minority-business subcontractors who do not submit the lowest responsible, responsive bid or bids.

SECTION B: DEFINITIONS

1. Minority - a person who is a citizen or lawful permanent resident of the United States and who is:
 - a. Black, that is, a person having origins in any of the black racial groups in Africa;
 - b. Hispanic, that is, a person of Spanish or Portuguese culture with origins in Mexico, South or Central America, or the Caribbean Islands, regardless of race;
 - c. Asian American, that is, a person having origins in any of the original peoples of the Far East, Southeast Asia and Asia, the Indian subcontinent, the Pacific Islands;
 - d. American Indian, that is, a person having origins in any of the original peoples of North America; or
 - e. Female
2. Minority Business - means a business:
 - a. In which at least fifty-one percent (51%) is owned by one or more minority persons, or in the case of a corporation, in which at least fifty-one percent (51%) of the stock is owned by one or more minority persons or socially and economically disadvantaged individuals; and
 - b. Of which the management and daily business operations are controlled by one or more of the minority persons or socially and economically disadvantaged individuals who own it.
3. Socially and economically disadvantaged individual - means the same as defined in 15 U.S.C. 637. "Socially disadvantaged individuals are those who have been subjected to racial or ethnic prejudice or cultural bias because of their identity as a member of a group without regard to their individual qualities". "Economically disadvantaged individuals are those socially disadvantaged individuals whose ability to compete in the free enterprise system has been impaired due to diminished capital and credit opportunities as compared to others in the same business area who are not socially disadvantaged".
4. Public Entity - means State and all public subdivisions and local governmental units.
5. Owner - The State of North Carolina, through the Agency/Institution named in the contract.
6. Designer - Any person, firm, partnership, or corporation, which has contracted with the State of North Carolina to perform architectural or engineering, work.
7. Bidder - Any person, firm, partnership, corporation, association, or joint venture seeking to be awarded a public contract or subcontract.

8. Contract - A mutually binding legal relationship or any modification thereof obligating the seller to furnish equipment, materials or services, including construction, and obligating the buyer to pay for them.
9. Contractor - Any person, firm, partnership, corporation, association, or joint venture which has contracted with the State of North Carolina to perform construction work or repair.
10. Subcontractor - A firm under contract with the prime contractor or construction manager at risk for supplying materials or labor and materials and/or installation. The subcontractor may or may not provide materials in his subcontract.

SECTION C: RESPONSIBILITIES

1. Office for Historically Underutilized Businesses, Department of Administration (hereinafter referred to as HUB Office).

The HUB Office has established a program, which allows interested persons or businesses qualifying as a minority business under G.S. 143-128.2, to obtain certification in the State of North Carolina procurement system. The information provided by the minority businesses will be used by the HUB Office to:

- a. Identify those areas of work for which there are minority businesses, as requested.
- b. Make available to interested parties a list of prospective minority business contractors and subcontractors.
- c. Assist in the determination of technical assistance needed by minority business contractors.

In addition to being responsible for the certification/verification of minority businesses that want to participate in the State construction program, the HUB Office will:

- (1) Maintain a current list of minority businesses. The list shall include the areas of work in which each minority business is interested.
- (2) Inform minority businesses on how to identify and obtain contracting and subcontracting opportunities through the State Construction Office and other public entities.
- (3) Inform minority businesses of the contracting and subcontracting process for public construction building projects.
- (4) Work with the North Carolina trade and professional organizations to improve the ability of minority businesses to compete in the State construction projects.
- (5) The HUB Office also oversees the minority business program by:
 - a. Monitoring compliance with the program requirements.
 - b. Assisting in the implementation of training and technical assistance programs.
 - c. Identifying and implementing outreach efforts to increase the utilization of minority businesses.
 - d. Reporting the results of minority business utilization to the Secretary of the Department of Administration, the Governor, and the General Assembly.

2. State Construction Office

The State Construction Office will be responsible for the following:

- a. Furnish to the HUB Office a minimum of twenty-one days prior to the bid opening the following:
 - (1) Project description and location;
 - (2) Locations where bidding documents may be reviewed;
 - (3) Name of a representative of the owner who can be contacted during the advertising period to advise who the prospective bidders are;
 - (4) Date, time and location of the bid opening.
 - (5) Date, time and location of prebid conference, if scheduled.
- b. Attending scheduled prebid conference, if necessary, to clarify requirements of the general statutes regarding minority-business participation, including the bidders' responsibilities.

- c. Reviewing the apparent low bidders' statutory compliance with the requirements listed in the proposal, that must be complied with, if the bid is to be considered as responsive, prior to award of contracts. The State reserves the right to reject any or all bids and to waive informalities.
- d. Reviewing of minority business requirements at Preconstruction conference.
- e. Monitoring of contractors' compliance with minority business requirements in the contract documents during construction.
- f. Provide statistical data and required reports to the HUB Office.
- g. Resolve any protest and disputes arising after implementation of the plan, in conjunction with the HUB Office.

3. Owner

Before awarding a contract, owner shall do the following:

- a. Develop and implement a minority business participation outreach plan to identify minority businesses that can perform public building projects and to implement outreach efforts to encourage minority business participation in these projects to include education, recruitment, and interaction between minority businesses and non-minority businesses.
- b. Attend the scheduled prebid conference.
- c. At least 10 days prior to the scheduled day of bid opening, notify minority businesses that have requested notices from the public entity for public construction or repair work and minority businesses that otherwise indicated to the Office for Historically Underutilized Businesses an interest in the type of work being bid or the potential contracting opportunities listed in the proposal. The notification shall include the following:
 - 1. A description of the work for which the bid is being solicited.
 - 2. The date, time, and location where bids are to be submitted.
 - 3. The name of the individual within the owner's organization who will be available to answer questions about the project.
 - 4. Where bid documents may be reviewed.
 - 5. Any special requirements that may exist.
- d. Utilize other media, as appropriate, likely to inform potential minority businesses of the bid being sought.
- e. Maintain documentation of any contacts, correspondence, or conversation with minority business firms made in an attempt to meet the goals.
- f. Review, jointly with the designer, all requirements of G.S. 143-128.2(c) and G.S. 143-128.2(f) – (i.e. bidders' proposals for identification of the minority businesses that will be utilized with corresponding total dollar value of the bid and affidavit listing good faith efforts, or affidavit of self-performance of work, if the contractor will perform work under contract by its own workforce) - prior to recommendation of award to the State Construction Office.
- g. Evaluate documentation to determine good faith effort has been achieved for minority business utilization prior to recommendation of award to State Construction Office.
- h. Review prime contractors' pay applications for compliance with minority business utilization commitments prior to payment.
- i. Make documentation showing evidence of implementation of Owner's responsibilities available for review by State Construction Office and HUB Office, upon request

4. Designer

Under the single-prime bidding, separate prime bidding, construction manager at risk, or alternative contracting method, the designer will:

- a. Attend the scheduled prebid conference to explain minority business requirements to the prospective bidders.
- b. Assist the owner to identify and notify prospective minority business prime and subcontractors of potential contracting opportunities.
- c. Maintain documentation of any contacts, correspondence, or conversation with minority business firms made in an attempt to meet the goals.
- d. Review jointly with the owner, all requirements of G.S. 143-128.2(c) and G.S.143-128.2(f) – (i.e. bidders' proposals for identification of the minority businesses that will be utilized with

corresponding total dollar value of the bid and affidavit listing Good Faith Efforts, or affidavit of self-performance of work, if the contractor will perform work under contract by its own workforce) - prior to recommendation of award.

- e. During construction phase of the project, review “MBE Documentation for Contract Payment” – (Appendix E) for compliance with minority business utilization commitments. Submit Appendix E form with monthly pay applications to the owner and forward copies to the State Construction Office.
- f. Make documentation showing evidence of implementation of Designer’s responsibilities available for review by State Construction Office and HUB Office, upon request.

5. Prime Contractor(s), CM at Risk, and Its First-Tier Subcontractors

Under the single-prime bidding, the separate-prime bidding, construction manager at risk and alternative contracting methods, contractor(s) will:

- a. Attend the scheduled prebid conference.
- b. Identify or determine those work areas of a subcontract where minority businesses may have an interest in performing subcontract work.
- c. At least ten (10) days prior to the scheduled day of bid opening, notify minority businesses of potential subcontracting opportunities listed in the proposal. The notification will include the following:
 - (1) A description of the work for which the subbid is being solicited.
 - (2) The date, time and location where subbids are to be submitted.
 - (3) The name of the individual within the company who will be available to answer questions about the project.
 - (4) Where bid documents may be reviewed.
 - (5) Any special requirements that may exist, such as insurance, licenses, bonds and financial arrangements.

If there are more than three (3) minority businesses in the general locality of the project who offer similar contracting or subcontracting services in the specific trade, the contractor(s) shall notify three (3), but may contact more, if the contractor(s) so desires.

- d. During the bidding process, comply with the contractor(s) requirements listed in the proposal for minority participation.
- e. Identify on the bid, the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit listing good faith efforts as required by G.S. 143-128.2(c) and G.S. 143-128.2(f).
- f. Make documentation showing evidence of implementation of PM, CM-at-Risk and First-Tier Subcontractor responsibilities available for review by State Construction Office and HUB Office, upon request.
- g. Upon being named the apparent low bidder, the Bidder shall provide one of the following: (1) an affidavit (Affidavit C) that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal; (2) if the percentage is not equal to the applicable goal, then documentation of all good faith efforts taken to meet the goal. Failure to comply with these requirements is grounds for rejection of the bid and award to the next lowest responsible and responsive bidder.
- h. The contractor(s) shall identify the name(s) of minority business subcontractor(s) and corresponding dollar amount of work on the schedule of values. The schedule of values shall be provided as required in Article 31 of the General Conditions of the Contract to facilitate payments to the subcontractors.
- i. The contractor(s) shall submit with each monthly pay request(s) and final payment(s), “MBE Documentation for Contract Payment” – (Appendix E), for designer’s review.
- j. During the construction of a project, at any time, if it becomes necessary to replace a minority business subcontractor, immediately advise the owner, State Construction Office, and the Director of the HUB Office in writing, of the circumstances involved. The prime contractor shall make a good faith effort to replace a minority business subcontractor with another minority business subcontractor.

- k. If during the construction of a project additional subcontracting opportunities become available, make a good faith effort to solicit subbids from minority businesses.
- l. It is the intent of these requirements apply to all contractors performing as prime contractor and first tier subcontractor under construction manager at risk on state projects.

6. **Minority Business Responsibilities**

While minority businesses are not required to become certified in order to participate in the State construction projects, it is recommended that they become certified and should take advantage of the appropriate technical assistance that is made available. In addition, minority businesses who are contacted by owners or bidders must respond promptly whether or not they wish to submit a bid.

SECTION 4: DISPUTE PROCEDURES

It is the policy of this state that disputes that involves a person's rights, duties or privileges, should be settled through informal procedures. To that end, minority business disputes arising under these guidelines should be resolved as governed under G.S. 143-128(g).

SECTION 5: These guidelines shall apply upon promulgation on state construction projects. Copies of these guidelines may be obtained from the Department of Administration, State Construction Office, (physical address) 301 North Wilmington Street, Suite 450, NC Education Building, Raleigh, North Carolina, 27601-2827, (mail address) 1307 Mail Service Center, Raleigh, North Carolina, 27699-1307, phone (919) 807-4100, Website: www.nc-sco.com

SECTION 6: In addition to these guidelines, there will be issued with each construction bid package provisions for contractual compliance providing minority business participation in the state construction program.

MINORITY BUSINESS CONTRACT PROVISIONS (CONSTRUCTION)

APPLICATION:

The **Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts** are hereby made a part of these contract documents. These guidelines shall apply to all contractors regardless of ownership. Copies of these guidelines may be obtained from the Department of Administration, State Construction Office, (physical address) 301 North Wilmington Street, Suite 450, NC Education Building, Raleigh, North Carolina, 27601-2827, (mail address) 1307 Mail Service Center, Raleigh, North Carolina, 27699-1307, phone (919) 807-4100, Website: <http://www.nc-sco.com>

MINORITY BUSINESS SUBCONTRACT GOALS:

The goals for participation by minority firms as subcontractors on this project have been set at 10%.

The bidder must identify on its bid, the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit (Affidavit A) listing good faith efforts or affidavit (Affidavit B) of self-performance of work, if the bidder will perform work under contract by its own workforce, as required by G.S. 143-128.2(c) and G.S. 143-128.2(f).

The lowest responsible, responsive bidder must provide Affidavit C, that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal.

OR

Provide Affidavit D, that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, **with documentation of Good Faith Effort, if the percentage is not equal to the applicable goal.**

OR

Provide Affidavit B, which includes sufficient information for the State to determine that the bidder does not customarily subcontract work on this type project.

The above information must be provided as required. Failure to submit these documents is grounds for rejection of the bid.

MINIMUM COMPLIANCE REQUIREMENTS:

All written statements, affidavits or intentions made by the Bidder shall become a part of the agreement between the Contractor and the State for performance of this contract. Failure to comply with any of these statements, affidavits or intentions, or with the minority business Guidelines shall constitute a breach of the contract. A finding by the State that any information submitted either prior to award of the contract or during the performance of the contract is inaccurate, false or incomplete, shall also constitute a breach of the contract. Any such breach may result in termination of the contract in accordance with the termination provisions contained in the contract. It shall be solely at the option of the State whether to terminate the contract for breach.

In determining whether a contractor has made Good Faith Efforts, the State will evaluate all efforts made by the Contractor and will determine compliance in regard to quantity, intensity, and results of these efforts. Good Faith Efforts include:

- (1) Contacting minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor or available on State or local government maintained lists at least 10 days before the bid or proposal date and notifying them of the nature and scope of the work to be performed.
- (2) Making the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bid or proposals are due.
- (3) Breaking down or combining elements of work into economically feasible units to facilitate minority participation.
- (4) Working with minority trade, community, or contractor organizations identified by the Office for Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- (5) Attending any prebid meetings scheduled by the public owner.
- (6) Providing assistance in getting required bonding or insurance or providing alternatives to bonding or insurance for subcontractors.
- (7) Negotiating in good faith with interested minority businesses and not rejecting them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- (8) Providing assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisting minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- (9) Negotiating joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- (10) Providing quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

Identification of HUB Certified/ Minority Business Participation

I, _____,
(Name of Bidder)

do hereby certify that on this project, we will use the following HUB Certified/ minority business as construction subcontractors, vendors, suppliers or providers of professional services.

Firm Name, Address and Phone #	Work Type	*Minority Category	**HUB Certified (Y/N)

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

** HUB Certification with the state HUB Office required to be counted toward state participation goals.

The total value of minority business contracting will be (\$)_____.

State of North Carolina AFFIDAVIT A – Listing of Good Faith Efforts

County of _____

(Name of Bidder)

Affidavit of _____

I have made a good faith effort to comply under the following areas checked:

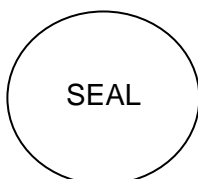
Bidders must earn at least 50 points from the good faith efforts listed for their bid to be considered responsive. (1 NC Administrative Code 30 I.0101)

- ☐ **1 – (10 pts)** Contacted minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor, or available on State or local government maintained lists, at least 10 days before the bid date and notified them of the nature and scope of the work to be performed.
- ☐ **2 --(10 pts)** Made the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bids are due.
- ☐ **3 – (15 pts)** Broken down or combined elements of work into economically feasible units to facilitate minority participation.
- ☐ **4 – (10 pts)** Worked with minority trade, community, or contractor organizations identified by the Office of Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- ☐ **5 – (10 pts)** Attended prebid meetings scheduled by the public owner.
- ☐ **6 – (20 pts)** Provided assistance in getting required bonding or insurance or provided alternatives to bonding or insurance for subcontractors.
- ☐ **7 – (15 pts)** Negotiated in good faith with interested minority businesses and did not reject them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- ☐ **8 – (25 pts)** Provided assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisted minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- ☐ **9 – (20 pts)** Negotiated joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- ☐ **10 - (20 pts)** Provided quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

The undersigned, if apparent low bidder, will enter into a formal agreement with the firms listed in the Identification of Minority Business Participation schedule conditional upon scope of contract to be executed with the Owner. Substitution of contractors must be in accordance with GS143-128.2(d) Failure to abide by this statutory provision will constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of the minority business commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____
 Signature: _____
 Title: _____



State of _____, County of _____
 Subscribed and sworn to before me this _____ day of _____ 20____
 Notary Public _____
 My commission expires _____

State of North Carolina --AFFIDAVIT B-- Intent to Perform Contract with Own Workforce.

County of _____

Affidavit of _____
(Name of Bidder)

I hereby certify that it is our intent to perform 100% of the work required for the _____
_____ contract.
(Name of Project)

In making this certification, the Bidder states that the Bidder does not customarily subcontract elements of this type project, and normally performs and has the capability to perform and will perform all elements of the work on this project with his/her own current work forces; and

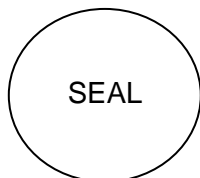
The Bidder agrees to provide any additional information or documentation requested by the owner in support of the above statement. The Bidder agrees to make a Good Faith Effort to utilize minority suppliers where possible.

The undersigned hereby certifies that he or she has read this certification and is authorized to bind the Bidder to the commitments herein contained.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina - AFFIDAVIT C - Portion of the Work to be Performed by HUB Certified/Minority Businesses

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the portion of the work to be executed by HUB certified/minority businesses as defined in GS143-128.2(g) and 128.4(a),(b),(e) is equal to or greater than 10% of the bidders total contract price, then the bidder must complete this affidavit.

This affidavit shall be provided by the apparent lowest responsible, responsive bidder within **72 hours** after notification of being low bidder.

Affidavit of _____ I do hereby certify that on the _____
(Name of Bidder)

(Project Name)
Project ID# _____ Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. Attach additional sheets if required

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

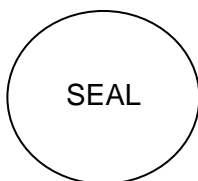
*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____



Signature: _____

Title: _____

State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina AFFIDAVIT D – Good Faith Efforts

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the goal of 10% participation by HUB Certified/ minority business **is not** achieved, the Bidder shall provide the following documentation to the Owner of his good faith efforts:

Affidavit of _____ I do hereby certify that on the _____
(Name of Bidder)

Project ID# _____ (Project Name) Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with HUB certified/ minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. (Attach additional sheets if required)

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Examples of documentation that may be required to demonstrate the Bidder's good faith efforts to meet the goals set forth in these provisions include, but are not necessarily limited to, the following:

- Copies of solicitations for quotes to at least three (3) minority business firms from the source list provided by the State for each subcontract to be let under this contract (if 3 or more firms are shown on the source list). Each solicitation shall contain a specific description of the work to be subcontracted, location where bid documents can be reviewed, representative of the Prime Bidder to contact, and location, date and time when quotes must be received.
- Copies of quotes or responses received from each firm responding to the solicitation.
- A telephone log of follow-up calls to each firm sent a solicitation.
- For subcontracts where a minority business firm is not considered the lowest responsible sub-bidder, copies of quotes received from all firms submitting quotes for that particular subcontract.
- Documentation of any contacts or correspondence to minority business, community, or contractor organizations in an attempt to meet the goal.
- Copy of pre-bid roster
- Letter documenting efforts to provide assistance in obtaining required bonding or insurance for minority business.
- Letter detailing reasons for rejection of minority business due to lack of qualification.
- Letter documenting proposed assistance offered to minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letter of credit, including waiving credit that is ordinarily required.

Failure to provide the documentation as listed in these provisions may result in rejection of the bid and award to the next lowest responsible and responsive bidder.

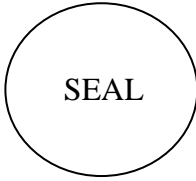
Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

APPENDIX E

MBE DOCUMENTATION FOR CONTRACT PAYMENTS

Prime Contractor/Architect: _____

Address & Phone: _____

Project Name: _____

Pay Application #: _____ Period: _____

The following is a list of payments made to Minority Business Enterprises on this project for the above-mentioned period.

MBE FIRM NAME	* INDICATE TYPE OF MBE	AMOUNT PAID THIS MONTH	TOTAL PAYMENTS TO DATE	TOTAL AMOUNT COMMITTED

*Minority categories: Black, African American (B), Hispanic (H), Asian American (A), American Indian (I), Female (F), Social and Economically Disadvantage (D)

Date: _____ Approved/Certified By: _____

Name

Title

Signature

SUBMIT WITH EACH PAY REQUEST & FINAL PAYMENT

Performance Bond

Date of Contract: _____

Date of Execution: _____

Name of Principal: _____

(Contractor): _____

Name of Surety: _____

Name of Contracting Body: _____ Edgecombe County Board of Education _____

Amount of Bond: _____

Project: _____

KNOW ALL MEN BY THESE PRESENTS, that we, the principal and surety above named, are held and firmly bound unto the above named contracting body, hereinafter called the contracting body, in the penal sum of the amount stated above for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal entered into a certain contract with the contracting body, identified as shown above and hereto attached:

NOW, THEREFORE, if the principal shall well and truly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract and any extensions thereof that may be granted by the contracting body, with or without notice to the surety, and during the life of any guaranty required under the contract, and shall also well and truly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the surety being hereby waived, then this obligation to be void; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals on the date indicated above, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Executed in _____ counterparts.

Witness: _____

Contractor (Trade or Corporate Name)

_____ By: _____

(Proprietorship or Partnership)

Attest: (Corporation) Title: _____

(Owner, Partner, or Corporate

President or Vice President Only)

By: _____

Title: _____ (CORPORATE SEAL)

(Corporate Secretary or Assistant Secretary only)

(Surety Company)

Witness: By: _____

_____ Title: _____

(Attorney in Fact)

Countersigned:

(North Carolina Licensed Resident Agent)

(SURETY CORPORATE SEAL)

Name and Address - Surety Agency

Surety Company Name and NC

Regional or Branch Office Address

Payment Bond

Date of Contract: _____

Date of Execution: _____

Name of Principal: _____

(Contractor): _____

Name of Surety: _____

Name of Contracting Body: Edgecombe County Board of Education

Amount of Bond: _____

Project: _____

KNOW ALL MEN BY THESE PRESENTS, that we, the principal and surety above named, are held and firmly bound unto the above named contracting body, hereinafter called the contracting body, in the penal sum of the amount stated above for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal entered into a certain contract with the contracting body, identified as shown above and hereto attached:

NOW, THEREFORE, if the principal shall promptly make payment to all persons supplying labor/material in the prosecution of the work provided for in said contract, and any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the surety being hereby waived, then this obligation to be void; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals on the date indicated above, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body. IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals on the date indicated above, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Executed in _____ counterparts.

Witness: _____

Contractor (Trade or Corporate Name)

_____ By: _____

(Proprietorship or Partnership)

Attest: (Corporation) Title: _____

(Owner, Partner, or Corporate

President or Vice President Only)

By: _____

Title: _____ (CORPORATE SEAL)

(Corporate Secretary or Assistant Secretary only)

(Surety Company)

Witness: By: _____

_____ Title: _____

(Attorney in Fact)

Countersigned:

(North Carolina Licensed Resident Agent)

(SURETY CORPORATE SEAL)

Name and Address - Surety Agency

Surety Company Name and NC

Regional or Branch Office Address

Bid Bond

FORM OF BID BOND

KNOW ALL MEN BY THESE PRESENTS, THAT WE _____
_____, as Principal, and _____
_____, as Surety, who is
duly licensed to act as Surety in North Carolina through the _____,
as Obligee, in the penal sum of _____

DOLLARS, lawful money of the United States of America, for the payment of which, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

SIGNED, sealed and dated this _____ day of _____, 20_____.

WHEREAS, the said Principal is herewith submitting Proposal for:

Edgecombe County Public Schools - Tarboro HS Chiller & Pump Upgrade

and the Principal desires to file this Bid Bond in lieu of making the cash deposit as required by G. S. 143-129:

NOW, THEREFORE, THE CONDITION OF THE ABOVE OBLIGATION is such, that if the Principal shall be awarded the Contract for which the bid is submitted and shall execute the Contract and give bond for the faithful performance thereof within ten days after the award of same to the Principal, then this obligation shall be null and void; but if the Principal fails to so execute such Contract and give Performance Bond as required by G. S. 143-129, the Surety shall upon demand, forthwith pay to the Obligee the amount set forth in the first paragraph hereof; and provided further, that the bid may be withdrawn as provided by G. S. 143-129.1.

_____(SEAL)

_____(SEAL)

_____(SEAL)

_____(SEAL)

**SECTION 00 90 00.04
INSURANCE CERTIFICATES (BLANK)**

PLACE HOLDER FOR ATTACHING SHEET

END OF SECTION 00 90 00.04

**SECTION 00 90 00.05
POWER OF ATTORNEY (BLANK)**

PLACE HOLDER FOR ATTACHING SHEET

END OF SECTION 00 90 00.05

**SECTION 01 10 00
SUMMARY**

PART 1 GENERAL

1.01 CONTRACT DESCRIPTION

- A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 00 52 00 - Agreement Form.

1.02 OWNER OCCUPANCY

- A. Owner intends to continue to occupy adjacent portions of the existing building during the entire construction period.
- B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- C. Schedule the Work to accommodate Owner occupancy.

1.03 CONTRACTOR USE OF SITE AND PREMISES

- A. Arrange use of site and premises to allow:
 - 1. Owner occupancy.
- B. Provide access to and from site as required by law and by Owner:
 - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.
- C. Utility Outages and Shutdown:
 - 1. Limit disruption of utility services to hours the building is unoccupied.
 - 2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 7 days notice to Owner and authorities having jurisdiction.
 - 3. Prevent accidental disruption of utility services to other facilities.

END OF SECTION 01 10 00

SECTION 01 14 00 WORK RESTRICTIONS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings, Notice to Bidders and Standard General Conditions of the Construction Contract, including Supplementary General Conditions and Division-1 Specification sections, apply to work of this section.

1.02 WORK SEQUENCE:

- A. Work shall begin after NTP. Work shall not disrupt service to Owner's facility.

1.03 WORK RESTRICTION:

- A. Behavior policy: All construction personnel shall be respectful of all state employees and visitors of the project site. Any incidents of disrespect, verbal abuse, threatening statements, unwelcome comments, unwelcome interaction or any form of harassment from any construction personnel toward any state employee or visitor is strictly prohibited. Any such act shall constitute sufficient cause for NC State to remove any individual permanently from the project and property. In addition, any of the contractor(s) project personnel who ignore or refuse to take action on any requirements of the contract documents; ignore or refuse to take immediate action to correct any endangerment to the health and safety of the public; as solely determined by NC State; then those actions shall be sufficient cause for NC State to permanently remove those individuals from the project and property. If in the sole determination of NC State, it would be in the best interest of the project and NC State to have any of the contractor(s) personnel removed from the project then the contractor shall do so upon request. Such actions taken shall not constitute grounds for a delay claim. NC State will not be responsible for any delays caused to the project due to any individual being removed from the project.
- B. Use of the Premises: Parking is limited on site and will be coordinated during construction.
- C. OSHA Compliance.
 - 1. It is the intent of NC State that all projects be designed in such a manner that they can be constructed and built in utilizing work practices in accordance with OSHA regulations. All Contractors and Subcontractors shall meet all requirements specified in 29 CFR 1910 and 1926, along with the Association of General Contractors Accident Prevention Manual.
 - 2. Contractors are referred to resources including, but not limited to, OSHA standards 1910 and 1926, and the Association of General Contractors Accident Prevention Manual. Also, each project will have a designated safety manager.
 - 3. The Contractor must designate, in writing, a safety manager for each project.
 - 4. It shall be the Contractor's responsibility to:
 - a. Provide a safe and healthful workplace free from recognized hazards to minimize the likelihood of accident or injury to all personnel.
 - b. Comply with OSHA standards 1910 and 1926, and any other applicable environmental health and safety regulations.
 - c. Comply with the requirements of the Association of General Contractors Accident Prevention Manual.
 - d. Provide adequate work-area protection to protect the safety and well-being of faculty, staff, and visitors.
 - e. Maintain an accurate list of chemicals used during construction, which must be made available to campus or other requesting personnel.
 - f. Establish and maintain an effective safety and health program involving all levels of the contracting organization, including managers, supervisors, and employees. A person designated as being responsible for safety must be present on site at all times work is in progress.
 - 1) Assure that a "competent person" as defined by OSHA is present during all projects that involve trenching or use of scaffolding.

**1.04 BUILDING ACCESS: THE BUILDING WILL BE FULLY OCCUPIED DURING CONSTRUCTION.
CONTRACTOR SHALL COORDINATE ALL CONSTRUCTION ACTIVITIES WITH THE OWNER.**

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION (NOT APPLICABLE)

END OF SECTION 01 14 00

**SECTION 01 20 00
PRICE AND PAYMENT PROCEDURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedures for preparation and submittal of applications for progress payments.
- B. Documentation of changes in Contract Sum and Contract Time.
- C. Procedures for preparation and submittal of application for final payment.

1.02 SCHEDULE OF VALUES

- A. Use Schedule of Values Form: AIA G703.
- B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Architect for approval.
- C. Forms filled out by hand will not be accepted.
- D. Submit Schedule of Values in duplicate within 20 days after date of Owner-Contractor Agreement.
- E. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification section. Identify site mobilization.
- F. Revise schedule to list approved Change Orders, with each Application For Payment.

1.03 APPLICATIONS FOR PROGRESS PAYMENTS

- A. Payment Period: Submit at intervals stipulated in the General and Supplementary Conditions.
- B. Use Form AIA G702 and Form AIA G703.
- C. Forms filled out by hand will not be accepted.
- D. Execute certification by signature of authorized officer.
- E. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.
- F. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of work.
- G. Submit one electronic and three hard-copies of each Application for Payment.
- H. Include the following with the application:
 - 1. Transmittal letter as specified for submittals in Section 01 30 00.
 - 2. Construction progress schedule, revised and current as specified in Section 01 30 00.
 - 3. State Tax form if required

1.04 MODIFICATION PROCEDURES

- A. For minor changes not involving an adjustment to the Contract Sum or Contract Time, Architect will issue instructions directly to Contractor.
- B. For changes for which advance pricing is desired, Architect will issue a document that includes a detailed description of a proposed change with supplementary or revised drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within 7 days.
- C. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.

1.05 APPLICATION FOR FINAL PAYMENT

- A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- B. Application for Final Payment will not be considered until the following have been accomplished:
 - 1. All closeout procedures specified in Section 01 70 00.

END OF SECTION 01 20 00

**SECTION 01 21 00
ALLOWANCES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Contingency allowance.

1.02 CONTINGENCY ALLOWANCE

- A. Contractor's costs for products, delivery, installation, labor, insurance, payroll, taxes, bonding, equipment rental, overhead and profit will be included in Change Orders authorizing expenditure of funds from this Contingency Allowance.
- B. Funds will be drawn from the Contingency Allowance only by Change Order.
- C. At closeout of Contract, funds remaining in Contingency Allowance will be credited to Owner by Change Order.

1.03 ALLOWANCES SCHEDULE

- A. Contingency Allowance: Include the stipulated sum/price of \$50,000 for use upon Owner's instructions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 21 00

**SECTION 01 23 00
ALTERNATES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Description of Alternates.
- B. Procedures for pricing Alternates.

1.02 ACCEPTANCE OF ALTERNATES

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in the Owner-Contractor Agreement.

1.03 SCHEDULE OF ALTERNATES

- A. Alternate No. 1 - Preferred Alternate for Section 23 09 00:
 - 1. Alternate Item: Section 23 09 00 and Drawing number ALL MECHANICAL SHEETS including Provide DDC controls by one manufacturer (ABB) installed by Envirocon. This shall include upgrading the front end for the entire school.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 23 00

**SECTION 01 25 00
SUBSTITUTION PROCEDURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedural requirements for proposed substitutions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
 - 2. Agrees to provide the same warranty for the substitution as for the specified product.
 - 3. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension that may subsequently become apparent.
- B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
- C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
 - 1. Forms indicated in the Project Manual are adequate for this purpose, and must be used.
- D. Limit each request to a single proposed substitution item.
 - 1. Submit an electronic document, combining the request form with supporting data into single document.

3.02 SUBSTITUTION PROCEDURES DURING PROCUREMENT

- A. Submittal Form (before award of contract):
 - 1. Submit substitution requests by completing the form attached to this section. See this form for additional information and instructions. Use only this form; other forms of submission are unacceptable.
- B. Owner will consider requests for substitutions only if submitted at least 10 days prior to the date for receipt of bids.

3.03 RESOLUTION

- A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.
- B. Architect will notify Contractor in writing of decision to accept or reject request.

3.04 ACCEPTANCE

- A. Accepted substitutions change the work of the Project. They will be documented and incorporated into work of the project by Change Order, Construction Change Directive, Architectural Supplementary Instructions, or similar instruments provided for in the Conditions of the Contract.

END OF SECTION 01 25 00

**SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General administrative requirements.
- B. Preconstruction meeting.
- C. Progress meetings.
- D. Construction progress schedule.
- E. Submittals for review, information, and project closeout.
- F. Number of copies of submittals.
- G. Requests for Interpretation (RFI) procedures.
- H. Submittal procedures.

1.02 GENERAL ADMINISTRATIVE REQUIREMENTS

- A. Comply with requirements of Section 01 70 00 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

- A. Architect will schedule a meeting after Construction Contracts are finalized.
- B. Attendance Required:
 - 1. Owner.
 - 2. Architect.
 - 3. Contractor.
- C. Agenda:
 - 1. Execution of Owner-Contractor Agreement.
 - 2. Submission of executed bonds and insurance certificates.
 - 3. Distribution of Contract Documents.
 - 4. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
 - 5. Designation of personnel representing the parties to Contract and Engineer.
 - 6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 - 7. Scheduling.
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.02 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the work at maximum bi-monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- C. Attendance Required:
 - 1. Contractor.
 - 2. Owner.
 - 3. Architect.
 - 4. Contractor's superintendent.
 - 5. Major subcontractors.
- D. Agenda:

1. Review minutes of previous meetings.
2. Review of work progress.
3. Field observations, problems, and decisions.
4. Identification of problems that impede, or will impede, planned progress.
5. Review of submittals schedule and status of submittals.
6. Maintenance of progress schedule.
7. Corrective measures to regain projected schedules.
8. Planned progress during succeeding work period.
9. Maintenance of quality and work standards.
10. Effect of proposed changes on progress schedule and coordination.
11. Other business relating to work.

- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.03 CONSTRUCTION PROGRESS SCHEDULE - SEE SECTION 01 32 16

- A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of work, with a general outline for remainder of work.

3.04 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
1. Product data.
 2. Shop drawings.
 3. Samples for selection.
 4. Samples for verification.
- B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
- C. Samples will be reviewed for aesthetic, color, or finish selection.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 78 00 - Closeout Submittals.

3.05 SUBMITTALS FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
1. Design data.
 2. Certificates.
 3. Test reports.
 4. Inspection reports.
 5. Manufacturer's instructions.
 6. Manufacturer's field reports.
 7. Other types indicated.
- B. Submit for Architect's knowledge as contract administrator or for Owner.

3.06 SUBMITTALS FOR PROJECT CLOSEOUT

- A. Submit Correction Punch List for Substantial Completion.
- B. Submit Final Correction Punch List for Substantial Completion.
- C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 78 00 - Closeout Submittals:
1. Project record documents.
 2. Operation and maintenance data.
 3. Warranties.
 4. Bonds.
 5. Other types as indicated.
- D. Submit for Owner's benefit during and after project completion.

3.07 NUMBER OF COPIES OF SUBMITTALS

- A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
 - 1. PDFs are to be bookmarked with appropriate sections.
- B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
 - 1. After review, produce duplicates.
 - 2. Retained samples will not be returned to Contractor unless specifically so stated.

3.08 SUBMITTAL PROCEDURES

- A. General Requirements:
 - 1. Use a single transmittal for related items.
 - 2. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
 - 3. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
 - 4. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
 - 5. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
 - a. Send submittals in electronic format via email to Architect.
 - 6. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - a. For each submittal for review, allow 10 business days excluding delivery time to and from the Contractor.
 - b. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 days.
 - 7. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
 - 8. Provide space for Contractor and Architect review stamps.
 - 9. When revised for resubmission, identify all changes made since previous submission.
- B. Shop Drawing Procedures:
 - 1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
 - 2. Do not reproduce Contract Documents to create shop drawings.
 - 3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

3.09 SUBMITTAL REVIEW

- A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.
- B. Submittals for Information: Architect will not acknowledge receipt, and take no other action.
- C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
 - 1. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.
- D. Architect's and consultants' actions on items submitted for review:
 - 1. Authorizing purchasing, fabrication, delivery, and installation:
 - a. "Approved", or language with same legal meaning.
 - b. "Approved as Noted, Resubmission not required", or language with same legal meaning.
 - 1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
 - 2) A corrected submittal shall be included in the closeout documents.
 - c. "Approved as Noted, Resubmit for Record", or language with same legal meaning.

- 1) Resubmit corrected item, with review notations acknowledged and incorporated.
Resubmit separately, or as part of project record documents.
 2. Not Authorizing fabrication, delivery, and installation:
 - a. "Revise and Resubmit".
 - 1) Resubmit revised item, with review notations acknowledged and incorporated.
 - b. "Rejected".
 - 1) Submit item complying with requirements of Contract Documents.
- E. Architect's and consultants' actions on items submitted for information:
 1. Items for which no action was taken:
 - a. "Received" - to notify the Contractor that the submittal has been received for record only.
 2. Items for which action was taken:
 - a. "Reviewed" - no further action is required from Contractor.

END OF SECTION 01 30 00

**SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preliminary schedule.
- B. Construction progress schedule, bar chart type.

1.02 SUBMITTALS

- A. Within 10 days after date of Agreement, submit preliminary schedule.
- B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
- D. Submit updated schedule with each Application for Payment.

1.03 SCHEDULE FORMAT

- A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.
- B. Diagram Sheet Size: Maximum 22 x 17 inches.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE

- A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 CONTENT

- A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- B. Identify each item by specification section number.
- C. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
- D. Provide legend for symbols and abbreviations used.

3.03 BAR CHARTS

- A. Include a separate bar for each major portion of Work or operation.
- B. Identify the first work day of each week.

3.04 UPDATING SCHEDULE

- A. Maintain schedules to record actual start and finish dates of completed activities.
- B. Indicate progress of each activity to date of revision, with projected completion date of each activity.
- C. Annotate diagrams to graphically depict current status of Work.
- D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
- E. Indicate changes required to maintain Date of Substantial Completion.
- F. Submit reports required to support recommended changes.

3.05 DISTRIBUTION OF SCHEDULE

- A. Distribute copies of updated schedules to Contractor's project site file, to subcontractors, suppliers, Architect, Owner, and other concerned parties.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

END OF SECTION 01 32 16

SECTION 01 40 00 QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. References and standards.
- B. Control of installation.
- C. Defect Assessment.

1.02 REFERENCES AND STANDARDS

- A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.
- C. Obtain copies of standards where required by product specification sections.
- D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.
- E. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.
- F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from Contract Documents by mention or inference otherwise in any reference document.

PART 3 EXECUTION

2.01 CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Have work performed by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

2.02 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not complying with specified requirements.

END OF SECTION 01 40 00

SECTION 01 60 00 PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Transportation, handling, storage and protection.
- B. Product option requirements.
- C. Substitution limitations.
- D. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 REFERENCE STANDARDS

- A. NEMA MG 1 - Motors and Generators 2021.

1.03 SUBMITTALS

- A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
 - 1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by Contract Documents.
- B. Use of products having any of the following characteristics is not permitted:
 - 1. Containing lead, cadmium, or asbestos.
- C. Motors: Refer to Section 21 05 13 - Common Motor Requirements for Fire Suppression Equipment, NEMA MG 1 Type. Specific motor type is specified in individual specification sections.
- D. Motors: Refer to Section 23 05 13 - Common Motor Requirements for HVAC Equipment, NEMA MG 1 Type. Specific motor type is specified in individual specification sections.

2.02 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.03 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

- A. See Section 01 25 00 - Substitution Procedures.

3.02 TRANSPORTATION AND HANDLING

- A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
- B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.
- C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- D. Transport and handle products in accordance with manufacturer's instructions.
- E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
- H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.03 STORAGE AND PROTECTION

- A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. See Section 01 74 19.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.
- D. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- G. Comply with manufacturer's warranty conditions, if any.
- H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- I. Prevent contact with material that may cause corrosion, discoloration, or staining.
- J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 01 60 00

SECTION 01 70 00 EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Examination, preparation, and general installation procedures.
- B. Requirements for alterations work, including selective demolition, _____.
- C. Cutting and patching.
- D. Cleaning and protection.
- E. Starting of systems and equipment.
- F. Demonstration and instruction of Owner personnel.
- G. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.

1.02 REFERENCE STANDARDS

- A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations 2022, with Errata (2021).

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - 1. Structural integrity of any element of Project.
 - 2. Integrity of weather exposed or moisture resistant element.
 - 3. Efficiency, maintenance, or safety of any operational element.
 - 4. Visual qualities of sight exposed elements.
 - 5. Work of Owner or separate Contractor.
- C. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.04 PROJECT CONDITIONS

- A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- B. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
 - 1. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Owner.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.

- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.04 ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of alterations work constitutes acceptance of existing conditions.
- B. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove items indicated on drawings.
 - 2. Relocate items indicated on drawings.
 - 3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
 - 4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.
- C. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
 - 2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
 - 3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
 - b. Provide temporary connections as required to maintain existing systems in service.
 - 4. Verify that abandoned services serve only abandoned facilities.

5. Remove abandoned pipe, ducts, conduits, and equipment , including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.
- D. Protect existing work to remain.
 1. Prevent movement of structure; provide shoring and bracing if necessary.
 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 3. Repair adjacent construction and finishes damaged during removal work.
- E. Adapt existing work to fit new work: Make as neat and smooth transition as possible.
- F. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
- G. Refinish existing surfaces as indicated:
 1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
 2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
- H. Clean existing systems and equipment.
- I. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.
- J. Do not begin new construction in alterations areas before demolition is complete.
- K. Comply with all other applicable requirements of this section.

3.05 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. See Alterations article above for additional requirements.
- C. Perform whatever cutting and patching is necessary to:
 1. Complete the work.
 2. Fit products together to integrate with other work.
 3. Provide openings for penetration of mechanical, electrical, and other services.
 4. Match work that has been cut to adjacent work.
 5. Repair areas adjacent to cuts to required condition.
 6. Repair new work damaged by subsequent work.
 7. Remove samples of installed work for testing when requested.
 8. Remove and replace defective and non-complying work.
- D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- G. Restore work with new products in accordance with requirements of Contract Documents.
- H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.
- J. Patching:
 1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

2. Match color, texture, and appearance.
3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.06 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.07 PROTECTION OF INSTALLED WORK

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.08 SYSTEM STARTUP

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
- C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- D. Verify that wiring and support components for equipment are complete and tested.
- E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.
- F. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.09 DEMONSTRATION AND INSTRUCTION

- A. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.
- B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- C. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of Owner's personnel.

3.10 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.11 FINAL CLEANING

- A. Use cleaning materials that are nonhazardous.

- B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- E. Clean filters of operating equipment.
- F. Clean debris from roofs, gutters, downspouts, and area drains.
- G. Clean site; sweep paved areas, rake clean landscaped surfaces.
- H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.12 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
 - 1. Provide copies to Architect and Owner.
- B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.
- C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.
- D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.
- E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.
- F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
- G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.
- H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

END OF SECTION 01 70 00

**SECTION 01 78 00
CLOSEOUT SUBMITTALS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Operation and Maintenance Data.
- B. Warranties and bonds.

1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- B. Individual Product Sections: Specific requirements for operation and maintenance data.
- C. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
- B. Operation and Maintenance Data:
 - 1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect will review draft and return one copy with comments.
 - 2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 3. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
 - 4. Submit two sets of revised final documents in final form within 10 days after final inspection.
- C. Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed shop drawings, product data, and samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Changes made by Addenda and modifications.

- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 3. Field changes of dimension and detail.
 - 4. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- A. For Each Product, Applied Material, and Finish:
 - 1. Product data, with catalog number, size, composition, and color and texture designations.
 - 2. Information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture protection and weather-exposed products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- D. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
- B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.
- C. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- D. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- E. Provide servicing and lubrication schedule, and list of lubricants required.
- F. Include manufacturer's printed operation and maintenance instructions.
- G. Include sequence of operation by controls manufacturer.

- H. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- I. Provide control diagrams by controls manufacturer as installed.
- J. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- K. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- L. Include test and balancing reports.
- M. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

- A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
- B. Where systems involve more than one specification section, provide separate tabbed divider for each system.
- C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 3 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.
- F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.
- G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.
- H. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.
- I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- J. Provide a PDF copy, properly bookmarked as well.

3.06 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.
- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Co-execute submittals when required.
- D. Retain warranties and bonds until time specified for submittal.
- E. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.

END OF SECTION 01 78 00

**SECTION 23 00 00
MECHANICAL ALTERNATES**

PART 1 GENERAL

1.01 LIST OF ALTERNATES

- A. Refer to Division 01 Specification and Bid Form for Alternates.

END OF SECTION 23 00 00 23 00 00

**SECTION 23 01 00
HVAC GENERAL PROVISIONS**

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall provide all materials, equipment and labor necessary to install and set into operation the heating and air conditioning equipment as shown on the Engineering Drawings and as contained herein.
- B. Intent of the drawings and specifications is to obtain complete systems, tested, adjusted, and ready for operation.
- C. Include incidental details not usually indicated or specified, but necessary for proper installation and operation.

1.02 QUALITY ASSURANCE

- A. Refer to the General and Supplementary General Conditions and Division 01.
- B. Check, verify, and coordinate work with drawings and specifications of other trades. Include modifications, relocations, and adjustments necessary to complete work or to avoid interference with other trades.
- C. All work shall be in accordance with local, state and federal regulations. Minimum requirements shall be the North Carolina State Building Code.
- D. The Contractor shall be responsible for obtaining all permits and shall notify inspection departments as work progresses.
- E. Whenever the words "Approval", "Approved", or "Approved Equal" appear, it is intended that items other than the model number specified shall be subject to the approval of the engineer.
- F. Where a submitted product has electrical requirements that differ from the Basis of Design specified product, it is the Mechanical Contractor's responsibility to coordinate the electrical requirements of the equipment with the Electrical Engineer and Electrical Contractor at no additional cost to the project.
- G. All material and equipment that the Contractor proposed to substitute in lieu of those specified in the Specifications, shall be submitted to the Engineer ten (10) days prior to the bid date for evaluation. The submittal shall include a full description of the material or equipment and all pertinent engineering data required to substantiate the equality of the proposed item to that specified. Items that are submitted for approval after this date will not be accepted.
- H. "Provide" as used herein shall mean that the Contractor responsible shall furnish and install said item or equipment. "Furnish" as used herein shall mean that the Contractor responsible shall acquire and make available said item or equipment and that installation shall be by others. "Install" as used herein shall mean that the Contractor responsible shall make installation of items or equipment furnished by others.
- I. Boiler Inspection Certificate - It shall be the responsibility of the Contractor to complete the installation of fired or unfired pressure vessels and their safety devices in accordance with the requirements of the latest edition of the North Carolina Department of Labor, "Boiler Inspection Law, Rules and Regulations".
 - 1. The Contractor shall be responsible for notifying the Bureau of Boiler Inspection in writing at least two weeks prior to the date of completion of all equipment requiring inspection. Certificates furnished by the Bureau of Boiler Inspection shall be installed in a frame having a removable glass cover and posted near the pressure vessel. Certificates shall be installed before requesting final inspection of the completed project. The pressure vessel is NOT to be operated before it is inspected and approved.

1.03 REQUIREMENT OF REGULATORY AGENCIES

- A. Rules and regulations of Federal, State, and local authorities having jurisdiction, and utility companies, in force at time of execution of contract shall become part of this specification.

1.04 SUBSTITUTIONS

- A. Products are specified for use on this project by one of the following:
 - 1. Reference Standards and Description: Any products meeting the Reference Standards and Description will be acceptable (i.e., piping).
 - 2. Naming of a product as an example to denote the quality standard of the product desired, in which case three or more brands will be denoted (where applicable) to establish equivalent designs. Naming of a product does not restrict Bidders to a specific brand (i.e., fixtures, valves, etc.).
 - 3. Requests for approval of manufacturer's or substitutions which have not been preapproved shall be made by using the forms at the end of this section.
- B. During bidding period: Submitted written requests from Bidders Only, using the forms herein, will be considered if received ten (10) calendar days prior to the date of receipt of bids to allow for proper evaluation. Requests from suppliers or subcontractors will not be considered. Substitutions will be considered when a product becomes unavailable through no fault of the Contractor. A request constitutes a representation that the Bidder/Contractor:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product and is suitable for use in the Work.
 - 2. Will provide the same warranty for the substitution as for the specified product.
 - 3. Will coordinate installation and make changes to other work which may be required for the work to be complete with no additional cost to the Owner.
 - 4. Waives claims for additional cost or time extension which may subsequently become apparent.
 - 5. Has included a list of similar projects on which this product has been used with names and telephone numbers for verification.
 - 6. Has written verification from the product manufacturer that this product has been in use a minimum of two (2) years on a project similar to this work.
 - 7. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- C. Architect/Engineer Review
 - 1. Review and approval will rely on manufacturer's literature and other data as outlined herein.
 - 2. Inadequacies in such submittals that fail to identify unsuitability are the responsibility of the parties making submittal.
- D. Substitution Procedure
 - 1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
 - 2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.
 - 3. Submit listing of similar projects.
 - 4. Submit manufacturer's written verification that product has been in use a minimum of two (2) years at similar projects.
 - 5. The Architect/Engineer will notify Contractor, in writing, of decision to accept or reject request.
 - 6. Products bid or incorporated in the work that are not specified and without written approval of the Architect/Engineer may not be acceptable, and if not, the Contractor will be required to furnish and install the products specified.
 - 7. The Architect/Engineer will issue written approvals of product substitutions to all Bidders. Substitutions are not approved without written approval.
 - 8. FORMS: Copy forms incorporated at the end of this section and use for all product substitution requests.

1.05 SUBMITTALS

- A. Refer to General and Supplementary General Conditions and Division 01.
- B. For satisfying submittal requirements for Division 23, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the term "Shop Drawings" may be used throughout the specifications.

- C. Within ten days after notification of the award of the Contract and written notice to begin work, the Contractor shall submit to the Architect/Engineer for approval a detailed list of equipment and material which he proposes to use. Items requiring submittal data for approval will be noted at this time.
- D. Mark general catalog sheets and drawings to indicate specific items submitted and their correlation to specific tagged equipment on the drawings. Cross out all nonapplicable or extraneous information that does not apply to the submitted equipment. Circle or otherwise clearly indicate applicable options.
- E. Contractor shall clearly indicate deviations (if any) from the project specifications on each submittal. Shop drawings accepted by the Engineer shall not relieve the Contractor of their responsibility to construct the work in accordance with the Contract Documents.
- F. Include proper identification of equipment or item by name and/or number, as indicated on the Drawings.
- G. Where manufacturer's reference numbers differ from those specified, clearly indicate such on the submittal.
- H. Where equipment or items specified include accessories, parts, and additional items under one designation, submittals shall be complete and include all required components.
- I. Equipment requiring electrical connections shall include composite wiring diagrams, motor efficiency, and power factor data. Wiring diagrams submitted shall be specific to project conditions.
- J. Where submittals cover products containing non-metallic materials, include MSDS sheets from the manufacturer stating physical and chemical properties of components and precautionary steps to be taken.
- K. The Contractor shall provide an electronic PDF copy of submittal data. The pdf shall contain complete submittal data on all products, methods, etc. proposed for use on the project.
- L. Each submittal shall bear the approval of the Contractor indicating that he has reviewed the data and found it to meet the requirements of the specifications as well as space limitations and other project conditions. The submittals shall be clearly identified showing project name, manufacturer's catalog number, and all necessary performance and fabrication data.
- M. The Contractor shall submit to the Engineer a set of accurately marked up plans indicating all changes encountered during the construction. Final payment will be contingent on receipt of these as-built plans.
- N. The Contractor shall furnish an electronic PDF copy of maintenance and operating instructions as outlined in Paragraph C (Execution), of this specification section.
- O. The Contractor shall submit to the Owner all certificates required for operating system in compliance with local, state and federal regulations.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All material and equipment shall be delivered and unloaded by the Contractor within the project site as noted herein or as directed by the Owner.
- B. The Contractor shall protect all material and equipment from breakage, theft, or weather damage. No material or equipment shall be stored on the ground.
- C. The material and equipment shall remain the property of the Contractor until the project has been completed and turned over to the Owner.

1.07 WORK CONDITIONS AND COORDINATION

- A. The Contractor shall review the electrical plans to establish points of connection and the extent of electrical work to be provided in his Contract. All electrical work shall be performed by a licensed electrical contracting firm.
- B. This Contractor shall be responsible for the final electrical connections to all equipment installed as part of his contract.

- C. Electrical work shall be in accordance with all local, state and national codes and as specified in Division 26.
- D. Where architectural features and elements govern location of work, refer to Architectural drawings prior to fabrication of materials or system components.
- E. Refer to the Structural Drawings to become familiar with structural member sizes, framing type and configuration, opening sizes, and other details that could impact the work. Failure to coordinate with the Work of other trades, resulting in relocation of installed work to coordinate with architectural and/or structural elements, shall NOT be allowed as a basis for extra compensation by the contractor.
- F. Where piping, ductwork, or other items are indicated to be routed in the webbing of joists or trusses, the mechanical contractor shall confirm with the General Contractor/Construction Manager and steel supplier the final joist/truss profile prior to fabricating or order materials. The actual final joist/truss profile shall be used in the BIM coordination effort.
- G. Openings for insulated piping shall be based on the outside diameter of the insulation with continuous insulation through the opening.
- H. Seal non-fire rated floor penetrations with non-shrink grout or urethane caulk, as appropriate.
- I. Seal non-rated wall openings with urethane caulk.
- J. Duct/pipe/conduit penetrations through floor slabs of mechanical platforms or slabs above the bottom floor shall have water stopped curb surrounding the pipe/duct/conduit opening. Coordinate with Construction Manager/General Contractor to confirm openings based on Coordination Drawings.
- K. Pipe, conduit and duct chases required for installation of work shall be provided by the General Contractor unless otherwise noted. This Contractor shall be responsible for coordinating the location of all required chases.
- L. All work shall be coordinated with other trades. Cutting of new work and subsequent patching shall be at the Contractor's expense at no extra cost to the Owner.
- M. Contractor shall review the complete construction document package and determine, prior to the bid, which portions of the above grade structural slabs are hard rock concrete and/or light weight insulating concrete. Contractor shall review the Structural Engineer's requirements for attachment of loads to slabs, joists, trusses, and other structural members. DO NOT exceed point loads on Structural Engineer's drawings and details. Unistrut and/or other support apparatus required to span multiple joists or beams shall be included in the Contractor's bid. No additional monies will be given for support steel or other components required to support Mechanical piping, duct, equipment, or other items.

1.08 GUARANTEE

- A. See the General and Supplementary General Conditions
- B. Where extended warranties or guarantees are available from the manufacturer, the Contractor shall prepare the necessary contract documents to validate these warranties as required by the manufacturer and present them to the Architect/Engineer.
- C. The Contractor shall include in his bid a full warranty and guarantee for a five (5) year period on the compressors for the refrigeration equipment, including all chillers. This warranty does not include labor following the first year's Labor and Material Warranty.

PART 2 PRODUCT

2.01 GENERAL REQUIREMENTS

- A. Materials and equipment shall be new, unless noted otherwise, of the highest grade and quality and free from defects or other imperfections. Materials and equipment found defective shall be removed and replaced at the contractor's expense.
- B. The contractor shall provide name plates for identification of all equipment, switches, panels, etc.
- C. The name plates shall be laminated phenolic plastic, black front and back with white core, white engraved letters (1/4" minimum) etched into the white core. Name plates shall be fastened with

sheet metal screws.

PART 3 EXECUTION

3.01 INSPECTION

- A. This Contractor shall examine the areas of completed work and shall insure that no defects or errors are present which would result in the poor application or installation of subsequent work.

3.02 TEMPORARY SERVICES

- A. Refer to Division 01

3.03 INSTALLATION

- A. All work shall be performed in a manner indicating proficiency in the trade.
- B. Contractor may install additional piping, fittings, valves, etc., not indicated on the drawings, for testing purposes or for convenience to facilitate installation of the work. Where such materials are installed, they shall comply with the specifications and shall be sizes to be compatible with system design. Remove such materials when they interfere with design conditions or as directed by the Engineer.
- C. Use of access panels in inaccessible ceilings for access to equipment, valves, dampers, etc., is not permitted, unless access panels are indicated on the Architectural reflected ceiling plans. Review any locations where additional access panels may be required with the Architect prior to incorporating into Work.
- D. This Contractor shall be responsible for completely cleaning the fireproofing from ALL materials or equipment installed as part of this Contract. This includes, but is not limited to, ductwork, piping, conduit, equipment, faceplates, boxes, disconnects, control panels, and cabling.
- E. All conduit, pipes, ducts, etc. shall be either parallel to building walls or plumb where installed in a vertical position and shall be concealed when located in architecturally finished areas.
- F. Any cutting or patching required for installation of this Contractor's work shall be kept to a minimum. Written approval shall be required by the Architect/Engineer if cutting of primary structure is involved.
- G. All patching shall be done in such a manner as to restore the areas or surfaces to match existing finishes.
- H. The Contractor shall lay out and install his work in advance of pouring concrete floors or walls. He shall furnish all sleeves to the General Contractor for openings through poured masonry floors or walls, above grade, required for passage of all conduits, pipes, or ducts installed by him. The Contractor shall provide all inserts and hangers required to support his equipment.
- I. The annular space around ALL wall and floor penetrations shall be properly sealed. For rated assemblies, a UL listed method shall be used. For non-rated wall and floors, the annular space shall be packed with mineral wool, or another suitable non-combustible material, and caulked air tight.
- J. Installation of piping and ductwork shall not interfere with walkways or service access.
- K. All trapeze hanger rods shall be cut to within 1" of the bottom nut.
- L. Provide minimum 1/2" thick closed cell elastomeric foam insulation, applied with adhesive, on lower edges of equipment and mechanical duct and pipe supporting elements suspended less than 7 ft above finished floors, platforms, or roofs.

3.04 PERFORMANCE

- A. The Contractor shall perform all excavation and backfill operations necessary for installation of his work.

3.05 ERECTION

- A. All support steel, angles, channels, pipes or structural steel stands and anchoring devices that may be required to rigidly support or anchor material and equipment shall be provided by this Contractor.

3.06 FIELD QUALITY CONTROL

- A. The Contractor shall conform to the requirements of Division 3 for concrete testing.
- B. All testing required for compliance with the Contract shall be as stated in subsequent sections.

3.07 ADJUST AND CLEAN

- A. All equipment and installed materials shall be thoroughly clean and free of all dirt, oil, grit, grease, etc.
- B. Clean piping and ductwork both internally and externally to remove dirt, dust, debris, and other foreign matter. When external surfaces of piping are rusted, clean and restore surface to original condition.
- C. Clean all equipment as recommended by the manufacturer.
- D. Factory painted equipment shall not be repainted unless damaged areas exist. These areas shall be touched up with a material suitable for intended service. In no event shall name plates be painted.
- E. Dirt, dust, and other foreign matter shall be blown and/or cleaned from coils, terminal devices, diffusers, registers, and grilles. Inspect all coils and comb coil fins where damaged to as-new condition prior to test and balance work.
- F. If the Owner has doubts or concerns about the cleanliness of the ductwork or air handling systems, the Owner reserves the right to have a third-party assessment performed by a board certified indoor environmental consultant to determine if the installation meets requirements as stipulated in the National Air Duct Cleaners Association (NADCA) Assessment, Cleaning, and Restoration of HVAC Systems. If duct systems or air handling units are found to have accumulated dirt or foreign matter on interior surfaces in violation of NADCA guidelines, the Contractor shall be responsible for all costs required to restore the air distribution system to new condition to the satisfaction of the Owner. This shall include payment for all costs associated with third party testing of the systems.
- G. At a scheduled meeting, the Contractor shall instruct the Owner or the Owner's representative in the operation and maintenance of all equipment installed under his Contract (in the presence of the Engineer).
- H. Equipment with filter media shall be run for a period of two (2) weeks after completion of work at which time a new filter media shall be installed with one change of filter media provided the Owner for future replacement. (Provide a total of three (3) sets).
- I. The Contractor shall adjust the tension on all belts six months after the final inspection.

3.08 TESTING AND BALANCING

- A. Tests for equipment, ductwork, piping, and other systems shall be performed as specified in their respective sections in accordance with technical requirements indicated.
- B. Provide equipment and devices required for testing, including fittings for additional openings as required for the test apparatus.
- C. All ductwork and piping inspections and testing shall be successfully completed with test reports reviewed and approved by the Engineer before concealment or application of covering materials.
- D. Testing shall be witnessed by the Engineer, unless otherwise indicated. Notify Engineer, Owner, Commission Authority, and other parties at least 72 hours in advance of testing date. Engineer, at his discretion, may opt not to witness a given test. In this case, The Construction Manager/General Contractor and/or CxA shall witness the test and forward results to Engineer for review.
- E. Contractor shall be responsible for certifying in writing all equipment and system test results. Certification shall include identification of portion of system tested, date, time, weather conditions, test criteria, testing medium, and pressure used, duration of test, and name and title of person signing test certification document. Results shall be submitted to Engineer within three (3) days of test completion.

3.09 MAINTENANCE AND OPERATING MANUAL

- A. The Contractor shall prepare a PDF version of the manual describing the proper maintenance and system operation. This manual shall not consist of standard factory printed data intended for dimension or design purposes (although these may be included), but shall be prepared to describe this particular job. This manual shall include the following:
 - 1. A check list for periodic maintenance of all equipment.
 - 2. Suggested setting of all controls and switches for normal operation, with description of control and its location.
 - 3. A check list for seasonal shutdown.
 - 4. Maintenance and spare parts data for each major piece of equipment.
 - 5. As-built wiring, interlock and control diagrams for equipment with color coding shown on wiring and interlock diagrams.
 - 6. Air and Water Balance Report.
- B. The PDF shall be indexed, bookmarked, dated and signed by the Contractor when completed.
- C. The operating and maintenance manuals shall be submitted to the Engineer for approval. When the manuals are considered complete by the Engineer, they will be turned over to the Owner for their permanent use.

END OF SECTION 23 01 00 23 01 00

SECTION 23 05 12 ELECTRICAL WORK

PART 1 GENERAL

1.01 DIVISION OF WORK

- A. This Contractor shall be responsible for the final electrical and the entire control connections and wiring to all equipment installed as part of his contract.
- B. Contractor shall review the electrical plans, where applicable, to establish points of connection and the extent of his electrical work to be provided in his contract.
- C. Unless otherwise noted, this Contractor shall wire from his equipment to disconnect switches, junction boxes, or panelboard circuit breakers as provided by the Electrical Contractor or as required by the existing conditions.
- D. All power and control wiring shall be in conduits. Refer to electrical specifications for conduit and conduit fittings.
- E. All electrical work shall be performed by a licensed electrician.
- F. All electrical work shall be in accordance with the State Building Code and all its supplements, the latest edition of the National Electrical Code and the electrical specifications.

PART 2 PRODUCT

2.01 GENERAL REQUIREMENTS

- A. All motor starters, disconnects, switches, relays, conduits, conductors, etc. that are required for a complete electrical power and/or control system shall conform to the requirements set forth by NEC.
- B. Refer to the plans for the type, size and electrical characteristics of the starters, disconnects, switches, relays, conductor and conduits.
- C. All conductors and conduits shall be sized as noted on the plans or As required per NEC.
- D. All individual motor starters for mechanical equipment (i.e., fans, pumps, etc.) shall be furnished and installed under Division 23.
- E. All relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aquastats, freezestats, line and low voltage thermostats, thermals, remote selector switches, remote push-button stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 23 shall be furnished, installed and wired under Division 23.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. All motor starters, disconnects, and switches shall be installed on or as close to the equipment they are serving as possible, or where shown on the plans.
- B. Electrical connection to equipment subject to vibration which develops objectionable noises shall be made from the conduit system with short lengths of flexible "Liquid-Tite" conduit. Connection to other equipment shall be made with rigid conduit.
- C. Conduits shall be run in a concealed space such as wall cavities, ceiling cavities, etc. except in the mechanical rooms where conduit may be run exposed.

END OF SECTION 23 05 12 23 05 12

**SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Single phase electric motors.
- D. Three phase electric motors.
- E. Electronically Commutated Motors (ECM).

1.02 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators 2017.
- C. NEMA MG 1 - Motors and Generators 2021.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- C. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.04 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of high efficiency motors.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Baldor Electric Company/ABB Group
- B. General Electric
- C. Leeson Electric Corporation
- D. Marathon
- E. Regal-Beloit Corporation (Century)
- F. Or Approved Equal

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service:
 - 1. Motors 3/4 HP and Smaller: 115 volts, single phase, 60 Hz.

2. Motors Larger than 3/4 Horsepower: 208/480 volts, three phase, 60 Hz as indicated on the Drawings.
- B. Nominal Efficiency:
 1. All motors shall be premium efficiency and meet or exceed the requirements of ASHRAE Standard 90.1-2013 and the North Carolina Energy Code.
 2. All motors shall conform to the efficiency standard for integral horsepower motors known as 10 CFR Part 431 Subpart B published by the US Department of Energy.
- C. Construction:
 1. Open drip-proof type except where specifically noted otherwise.
 2. Design for continuous operation in 104 degrees F environment.
 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- D. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.
- E. Motors driven by variable frequency drives (VFDs) shall be inverter duty and have a shaft grounding ring.
- F. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- G. Wiring Terminations:
 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

- A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.
- B. Motors located in exterior locations, air cooled condensers, humidifiers, direct drive axial fans, and explosion proof environments: Totally enclosed type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Starting Torque: Less than 150 percent of full load torque.
- B. Starting Current: Up to seven times full load current.
- C. Breakdown Torque: Approximately 200 percent of full load torque.

2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Insulation System: NEMA Class B or better.
- E. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- F. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- G. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

- H. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- I. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.
- J. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.
- D. Motors with belt drives shall have adjustable motor mountings. Motor mounts shall have adjustable locking device for fixing motor position.
- E. Motor starters shall be installed as close to the motors they are serving as possible.
- F. Motor starters shall be installed at locations and heights to meet all State requirements and National Electric Code.

END OF SECTION 23 05 13

**SECTION 23 05 17
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe sleeves.
- B. Manufactured sleeve-seal systems.

1.02 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2022a.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).

1.03 SUBMITTALS

- A. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

- A. Non-manufactured sleeves:
 - 1. Cast iron or Schedule 40 steel
- B. Vertical Piping:
 - 1. Sleeve Length: 2 inch above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- C. Pipe Passing Through Below Grade Foundation Walls or Exterior Walls:
 - 1. Manufactured sleeve-seal system
 - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- D. Non-rated interior stud wall Penetrations:
 - 1. Pack annular space with mineral wool and seal tight with caulk
- E. Non-rated interior CMU wall Penetrations:
 - 1. Pack annular space with mineral wool and seal with non-shrink grout.
- F. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Floor, and Partitions: 1 inch greater than external pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 to prevent the spread of fire, smoke, and gases.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A. Manufacturers:
 - 1. Advance Products & Systems, LLC
 - 2. Flexicraft Industries
 - 3. GPT Industries
 - 4. Or Approved Equal
- B. Modular/Mechanical Seal:
 - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
 - 2. Provide watertight seal between pipe and wall/casing opening.
 - 3. Elastomer element size and material in accordance with manufacturer's recommendations.
 - 4. Service Requirements:
 - a. Corrosion resistant.
 - b. Oil, fuel, gas, and solvent resistant.
 - c. Underground, buried, and wet conditions.
 - d. High Temperature, up to 400 degrees F.
 - e. Low temperature, down to minus 67 degrees F.
 - 5. Glass reinforced plastic pressure end plates.
- C. Sealing Compounds:
 - 1. Provide packing and sealing compound to fill pipe to sleeve thickness.
 - 2. Combined packing and seal compound is to match partition fire-resistance hourly rating.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Structural Considerations:
 - 1. Do not penetrate building structural members unless approved by the Structural Engineer.
- E. Provide sleeves when penetrating footings, floors, and walls. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 - 1. Aboveground Piping:
 - a. Pack solid using mineral fiber in compliance with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
 - 2. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
- F. Manufactured Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior walls at piping entrances into building.
 - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 - 3. Locate piping in center of sleeve or penetration.
 - 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 - 5. Tighten bolting for a water-tight seal.
 - 6. Install in accordance with manufacturer's recommendations.

- G. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

- A. Upon completion of work, clean all parts of the installation.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION 23 05 17

**SECTION 23 05 19
METERS AND GAUGES FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure gauges and pressure gauge taps.
- B. Thermometers and thermometer wells.

1.02 REFERENCE STANDARDS

- A. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers 2014 (Reapproved 2020).
- B. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers 2014 (Reapproved 2021).

1.03 SUBMITTALS

- A. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- B. Project Record Documents: Record actual locations of components and instrumentation.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1.04 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc
 - 2. Moeller Instrument Company, Inc
 - 3. Omega Engineering, Inc
 - 4. U.S. Gauge
 - 5. Or Approved Equal
- B. Pressure Gauges: Liquid filled, 316L stainless steel case and bezel ring, seamless 316L stainless steel bourdon tube, 304 stainless steel movement, 316L stainless steel process connection, with front recalibration adjustment, white aluminum dial with black lettering.
 - 1. 4" diameter
 - 2. Range: 0-100 psi or to match system pressure
 - 3. Accuracy: +/- 1% of full scale
 - 4. Window: Shatter resistant glass or polycarbonate
 - 5. Pointer: Aluminum, black painted
 - 6. Working Pressure: 125% of full scale
 - 7. Working temperature:
 - a. Ambient: -40 - 140 Degrees F
 - b. Fluid: -4 - 212 Degrees F
 - 8. Weather Protection: NEMA 4X/IP67
 - 9. Liquid: Glycerin, Mineral oil, or Silicon oil

2.02 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers:

1. Dwyer Instruments, Inc
 2. Omega Engineering, Inc
 3. Weksler Glass Thermometer Corp
 4. Or Approved Equal
- B. Thermometers - Adjustable Angle: Blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
1. Size: 9 inch scale.
 2. Window: Clear Lexan.
 3. Stem: 3/4 inch 304 stainless steel.
 4. Accuracy: 1 percent Full Scale, ASME B40.3.
 5. Calibration: Degrees F.
 6. Range:
 - a. Chilled Water: 0 - 120 Degrees F

2.04 DIGITAL/SOLAR POWERED THERMOMETERS

- A. Manufacturers:
1. Wiess
 2. Trerice
 3. Zoro Select
- B. Thermometers - Adjustable Angle: Digital Display readout - 9/16" tall; ASTM E1; housing - ABS plastic, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
1. Size: 9 inch scale.
 2. Stem: 3.5 inch 304 stainless steel.
 3. Accuracy: 1 percent Full Scale, ASME B40.3.
 4. Calibration: Degrees F.
 5. Range:
 - a. Water: -50 - 300 Degrees F

2.05 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.06 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.
- B. Test Kit: Carrying case, internally padded and fitted containing one 3-1/2 inch diameter pressure gauges, two gauge adapters with 1/8 inch probes, two 1-1/2 inch dial thermometers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide pressure gauges per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- C. Install pressure gauges with pulsation dampers. Provide ball valve to isolate each gauge. Extend nipples to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- E. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 09 00. Where thermometers are provided on local panels, duct or pipe

mounted thermometers are not required.

- F. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- G. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- H. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- I. Locate test plugs adjacent to pressure gages and pressure gage taps and thermometers and thermometer sockets.

END OF SECTION 23 05 19

**SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Applications.
- B. Ball valves.
- C. Butterfly valves.
- D. Check valves.
- E. Plug valves.
- F. Chainwheels.

1.02 ABBREVIATIONS AND ACRONYMS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. SWP: Steam working pressure.
- I. TFE: Tetrafluoroethylene.
- J. WOG: Water, oil, and gas.

1.03 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch 2013 (Reaffirmed 2018).
- B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- E. ASME B31.9 - Building Services Piping 2020.
- F. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.
- G. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2022.
- H. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).
- I. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures 1999 (Reapproved 2022).
- J. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
- K. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
- L. AWWA C606 - Grooved and Shouldered Joints 2022.
- M. MSS SP-68 - High Pressure Butterfly Valves with Offset Design 2021.
- N. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.
- O. MSS SP-108 - Resilient-Seated Cast Iron Eccentric Plug Valves 2020.

- P. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .
- Q. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided 2018.

1.04 SUBMITTALS

- A. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- B. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- C. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.

1.05 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.
 - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - 4. Secure check valves in either the closed position or open position.
 - 5. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 - 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.
- C. Exercise the following precautions for handling:
 - 1. Handle large valves with sling, modified to avoid damage to exposed parts.
 - 2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).
- B. Provide the following valves for the applications if not indicated on drawings:
 - 1. Isolation (Shutoff): Butterfly and Ball.
 - 2. Swing Check (Pump Outlet):
 - a. Size 2 inch and Smaller: Bronze with bronze disc.
 - b. 2-1/2 NPS and Larger: Iron with center-guided with resilient seat.
 - 3. Dead-End: Butterfly, single-flange (lug) type.
- C. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.
- D. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:

- a. Size 2 inch and Smaller: Threaded ends.
 - b. Size 2-1/2 inch and Larger: Welded.
- 2. Copper Tube:
 - a. 2 NPS and Smaller: Solder-joint valve-ends.
- E. Chilled Water Valves:
 - 1. 2 NPS and Smaller, Bronze Valves:
 - a. Threaded ends for steel pipe.
 - b. Soldered ends for copper pipe.
 - c. Ball: Full port, two piece, stainless steel trim.
 - d. Swing Check: Bronze disc, Class 150.
 - 2. 2-1/2 NPS and Larger, Iron Valves:
 - a. Butterfly: High performance, single flange, Class 150.
 - b. Center-Guided Check: Compact-wafer, resilient seat, Class 150.
 - c. Eccentric Plug: Resilient seating, 175 CWP.

2.02 MANUFACTURERS

- A. Provide all valves of each type from a single manufacturer.
- B. Manufacturers:
 - 1. Anvil
 - 2. Apollo
 - 3. Crane
 - 4. Hammond
 - 5. ITT Grinnell
 - 6. Milwaukee
 - 7. Nibco
 - 8. Powell
 - 9. Victaulic
 - 10. Or Approved Equal

2.03 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
 - 2. Handwheel: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 NPS and smaller.
 - 4. Wrench: Plug valves with square heads.
 - 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- D. Valves in Insulated Piping: Provide 2-1/4" stem extensions and the following features:
 - 1. Chilled Water Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 2. Hot Water Ball Valves: Metal stem extension is acceptable.
 - 3. Butterfly Valves: Extended neck.
- E. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.
 - 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 - 3. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.
 - 4. Solder Joint Connections: ASME B16.18.
 - 5. Grooved End Connections: AWWA C606.
- F. General ASME Compliance:
 - 1. Building Services Piping Valves: ASME B31.9.

- G. Bronze Valves:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- H. Source Limitations: Obtain each valve type from a single manufacturer.

2.04 BRONZE, BALL VALVES

- A. General:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Two Piece, Full Port with Stainless Steel Trim:
 - 1. Comply with MSS SP-110.
 - 2. SWP Rating: 150 psig.
 - 3. CWP Rating: 600 psig.
 - 4. Body: Bronze
 - 5. Stem: 316 Stainless steel.
 - 6. Ball: Stainless steel vented.
 - 7. Handle: Provide lever handle with 2-1/4" stem extension for insulation. On chilled water valves or other fluids below ambient temperature, use non-conductive handle extensions.

2.05 HIGH-PERFORMANCE SINGLE FLANGE BUTTERFLY VALVES

- A. Lug type: Bi-directional dead end service without downstream flange.
 - 1. Comply with MSS SP-68.
 - 2. Class 150: CWP Rating: 285 psig at 100 degrees F.
 - 3. Body: Provide ductile Iron.
 - 4. Seat: Metal or reinforced PTFE.
 - 5. Offset stem: Stainless steel.
 - 6. Disc: Stainless steel or Aluminum-bronze.

2.06 BRONZE SWING CHECK VALVES

- A. Class 150: CWP Rating: 300 psig (2070 kPa).
 - 1. Comply with MSS SP-80, Type 3.
 - 2. Body Design: Horizontal flow.
 - 3. Body Material: Bronze, ASTM B62.
 - 4. Ends: Threaded.
 - 5. Disc: Bronze.

2.07 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 150, Compact-Wafer:
 - 1. Comply with MSS SP-125.
 - 2. 2-1/2 NPS to 12 NPS, CWP Rating: 300 psig.
 - 3. Body Material: ASTM A395/A395M or ASTM A536, ductile iron or cast iron.
 - 4. Resilient Seat: EPDM or NBR.

2.08 ECCENTRIC PLUG VALVES

- A. Resilient Seating with Flanged Ends.
 - 1. Comply with MSS SP-108.
 - 2. CWP Rating: 175 psig minimum.
 - 3. Body and Plug: Gray or ductile iron.
 - 4. Bearings: Oil-impregnated bronze or Stainless Steel.
 - 5. Stem-Seal Packing: Asbestos free.
 - 6. Plug, Resilient-Seating Material: Approved for potable water service.

2.09 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.

2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve be determined to be defective, replace with new valve.

3.02 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. All valves shall be installed within 24" of the lay-in ceiling.
- C. DO NOT install valves above cable tray.
- D. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- E. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- F. Install check valves where necessary to maintain direction of flow as follows:
 1. Swing Check: Install horizontal maintaining hinge pin level.
 2. Orient center-guided into horizontal or vertical position, between flanges.
- G. Provide chainwheels on operators for valves 8" and larger where located 96" or more above finished floor, terminating 60" above finished floor.

END OF SECTION 23 05 23

**SECTION 23 05 33
HEAT TRACING FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Self-regulating parallel resistance electric heating cable.

1.02 REFERENCE STANDARDS

- A. IEEE 515.1 - IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications 2022.
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL (DIR) - Online Certifications Directory Current Edition.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with other trades to provide ground fault protection for electric heat tracing circuits as required by NFPA 70.
- B. Coordinate the work with other trades to provide circuit breaker ratings suitable for installed circuit lengths.

1.04 SUBMITTALS

- A. Product Data: Provide data for electric heat tracing.
- B. Shop Drawings: Indicate electric heat tracing layout, electrical terminations, thermostats, controls, and branch circuit connections.
- C. Manufacturer's Installation Instructions: Indicate installation instructions and recommendations.
- D. Sizing table indicating pipe size, insulation thickness, fluid temperature, ambient temperature, and W/ft of cable selected.
- E. Field Quality Control Submittals: Indicate test reports and inspection reports.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, maintenance and repair data, and parts listings.
- G. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- H. Project Record Documents: Record actual locations of electric heat tracing lines and thermostats.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with at least three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 WARRANTY

- A. Provide two year manufacturer warranty for cables, connection kits, accessories, and controls.

PART 2 PRODUCTS

2.01 SELF-REGULATING PARALLEL RESISTANCE ELECTRIC HEATING CABLE

- A. Manufacturers:
 - 1. Chromalox, Inc
 - 2. Pentair
 - 3. Raychem
 - 4. Thermon Manufacturing Company
 - 5. Or Approved Equal
- B. Provide products listed, classified, and labeled by UL (DIR) or testing firm acceptable to authorities having jurisdiction (AHJ).

- C. All heat-tracing applications with continuous exposure temperatures from 150 degrees F to 250 degrees F or intermittent exposure temperatures from 185 degrees F to 420 degrees F shall use self-regulating cables.
- D. Self-regulating cable shall vary its power relative to the temperature of the surface of the pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.
- E. Self-regulating heating cable shall be designed for a useful life of 20 years or more with "power on" continuously, based on the following useful life criteria:
 - 1. Retention of at least 75 percent of nominal rated power after 20 years of operation at the maximum published continuous exposure (maintain) temperature.
 - 2. Retention of at least 90 percent of nominal rated power after 1000 hours of operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 746B, IEC 216-1 Part 1.
- F. All cables shall be capable of passing a 2.5 kV dielectric test for one minute (ASTM 2633) after undergoing a 0.5 kg-m impact.
- G. Factory Rating and Testing: Comply with IEEE 515.1.
- H. Heating Element:
 - 1. Provide pair of parallel No. 16 nickel coated stranded copper bus wires embedded in cross linked conductive polymer core with varying heat output in response to temperature along its length so that cable may be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) of T6 (185 degrees F) without the use of thermostats.
 - 2. Terminations: Waterproof, factory assembled, non-heating leads with connector at one end and water-tight seal at opposite end.
 - 3. Capable of crossing over itself without overheating.
- I. Insulated Jacket: Flame retardant polyolefin.
- J. Minimum Self-Regulating Indices:

Heating Cable	S.R. Index (W/deg F)
1. 3 W/ft	0.038
2. 5 W/ft	0.060
3. 8 W/ft	0.074
4. 10 W/ft	0.100
- K. The self-regulating index is the rate of change of power output in watts per degree Fahrenheit as measured by the temperatures of 50 degree F and 100 degree F and confirmed by the type of test and published data sheets.
- L. In order to ensure that the self-regulating heating cable does not increase power output when accidentally exposed to high temperatures, resulting in thermal run-away and self-ignition, the cable shall produce less than 0.5 watts per foot when energized and heated to 350 degrees F for 30 minutes. After this test, if the cable is reenergized, it must not have an increasing power output leading to thermal runaway.
- M. The self-regulating cable shall retain at least 90 percent of its original power output after having been cycled 300 times between 50 degrees F and 210 degrees F, allowing at least six minutes of dwell time at each temperature.
- N. Cable Cover: Provide tinned copper and polyolefin outer jacket with UV inhibitor.
- O. A integral ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be included and used to protect each circuit.
- P. Maximum Power-On Operating Temperature: 150 degrees F.
- Q. Maximum Power-Off Exposure Temperature: 185 degrees F.

2.02 OUTER JACKET MARKINGS

- A. Name of manufacturer, trademark, or other recognized symbol of identification.

- B. Catalog number, reference number, or model.
- C. Month and year of manufacture, date coding, applicable serial number, or equivalent.
- D. Agency listing or approval.
- E. Applicable environmental or area use requirements, such as NEMA 4, Type 4, IP ratings, and hazardous (classified) location markings including temperature rating.
- F. Any applicable warning/caution statements such as "WARNING: De-energize circuit before removing cover.

2.03 CONNECTION KITS

- A. Name of manufacturer, trademark, or other recognized symbol of identification.
- B. Provide power connection, splice/tee, and end seal kits compatible with the heating cable and without requiring cutting of the cable core to expose bus wires.
- C. Furnish with NEMA 4X rating for prevention of corrosion and water ingress.
- D. Provide UV stabilized components.

2.04 ACCESSORIES

- A. Provide Accessories As Indicated or As Required for Complete Installation, Including but Not Limited To:
 - 1. High temperature, glass filament tape for attachment of heating cable to metal piping.
 - 2. Aluminum self-adhesive tape for attachment of heating cable to plastic piping.
 - 3. Cable ties.
 - 4. Silicone end seals and splice kits.
 - 5. Installation clips.
 - 6. Warning labels for attachment to exterior of piping insulation. Refer to Section 23 05 53.
 - 7. Provide integral GFCI protection for all heat trace.

2.05 CONTROLS

- A. Pipe Mounted Thermostats:
 - 1. Remote bulb on capillary, resistance temperature device (RTD) or thermistor for direct sensing of pipe wall temperature.
 - 2. Provide pilot light indicator.
 - 3. Provide a Control Enclosure for each chiller.
 - 4. Control Enclosure: Corrosion resistant and waterproof.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping and equipment are ready to receive work.
- B. Verify required power is available, in proper location, and ready for use.

3.02 PREPARATION

- A. Clean all surfaces prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Comply with installation requirements of IEEE 515.1 and NFPA 70, Article 427.
- C. Apply heating cable linearly on pipe with fiberglass tape only after piping has successfully completed any required pressure testing.
- D. Comply with all national and local code requirements.
- E. Identification:
 - 1. After thermal insulation installation, apply external pipeline decals to indicate presence of the thermal insulation cladding at intervals not to exceed 20 ft including cladding over each valve

or other equipment that may require maintenance.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Field Testing and Inspections:
 - 1. Commission system in accordance with installation and operation manual.
 - 2. Inspect for sources of water entry and proper sealing.
 - 3. Inspect weather barrier to confirm that no sharp edges are contacting the trace heating.
 - 4. Minimum Acceptable Insulation Resistance: 20 megohms or greater at a test voltage of 2500 VDC for polymer insulated trace heaters.
 - 5. Test heating cable integrity with megohmmeter at the following intervals:
 - a. Before installing the cable.
 - b. Prior to initial start-up (commissioning).
 - 6. Measure voltage and current at each unit.
 - 7. Controls:
 - a. Verify control parameters are set to the application requirements.
 - 8. Submit written test report showing values measured on each test for each cable.

3.05 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 23 05 33

**SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Vibration isolators.

1.02 REFERENCE STANDARDS

- A. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications Most Recent Edition Cited by Referring Code or Reference Standard.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 - 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
- B. Shop Drawings - Vibration Isolation Systems:
 - 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.

1.05 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

- A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
 - 3. Select vibration isolators for outdoor equipment to comply with wind design requirements.
- D. Equipment Isolation: As indicated on drawings.
- E. Piping Isolation:
 - 1. Provide vibration isolators for piping supports:
 - a. Located in equipment rooms.

- b. Located within 50 feet of connected vibration-isolated equipment and pressure-regulating valve (PRV) stations.
- 2. Minimum Static Deflection:
 - a. First Three Supports Closest to Isolated Equipment: Same as static deflection of equipment; maximum of 2 inch deflection required.
 - b. Remainder of Supports: 0.75 inch deflection unless otherwise indicated.
- 3. Suspended Piping, Nonseismic Applications: Use resilient material isolator hangers, spring isolator hangers, or combination resilient material/spring isolator hangers.

2.02 VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Vibration Isolators:
 - a. Kinetics Noise Control, Inc
 - b. Mason Industries
 - c. Vibration Eliminator Company, Inc
 - d. The VMC Group/Amber Booth
 - e. Or Approved Equal
 - 2. Source Limitations: Furnish vibration-isolators and associated accessories produced by a single manufacturer and obtained from a single supplier.
- B. General Requirements:
 - 1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
 - 2. Spring Elements for Spring Isolators:
 - a. Color code or otherwise identify springs to indicate load capacity.
 - b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
 - c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
 - d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
 - e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
 - f. Selected to function without undue stress or overloading.
- C. Vibration Isolators for Nonseismic Applications:
 - 1. Resilient Material Isolator Pads:
 - a. Description: Single or multiple layer pads utilizing elastomeric (e.g. neoprene, rubber) isolator material.
 - b. Pad Thickness: As required for specified minimum static deflection; minimum 0.25 inch thickness.
 - c. Multiple Layer Pads: Provide bonded, galvanized sheet metal separation plate between each layer.
 - 2. Housed Spring Isolators:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing.
 - b. Furnished with integral elastomeric snubbing elements, adjustable type, for limiting equipment movement and preventing metal-to-metal contact between housing elements.
 - c. Bottom Load Plate: Steel with nonskid, elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - d. Furnished with integral leveling device for positioning and securing supported equipment.
 - 3. Resilient Material Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g. neoprene, rubber) isolator material for the lower hanger rod connection.
 - 4. Spring Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series

- with an elastomeric element for the lower hanger rod connection.
- b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Secure fasteners according to manufacturer's recommended torque settings.
- D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- E. Vibration Isolation Systems:
 - 1. Isolator Hangers:
 - a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.
 - b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.
 - 2. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
 - 3. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
 - 4. Adjust isolators to be free of isolation short circuits during normal operation.
 - 5. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

3.03 FIELD QUALITY CONTROL

- A. Inspect vibration isolation and/or seismic control components for damage and defects.
- B. Vibration Isolation Systems:
 - 1. Verify isolator static deflections.
 - 2. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.
- C. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION 23 05 48

**SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe markers.

1.02 REFERENCE STANDARDS

- A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials 2017.

1.03 SUBMITTALS

- A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Automatic Controls: Tags. Key to control schematic.
- B. Control Panels: Nameplates.
- C. Heat Transfer Equipment: Nameplates.
- D. Instrumentation: Tags.
- E. Major Control Components: Nameplates.
- F. Piping: Stencilled painting.
- G. Pumps: Nameplates.
- H. Relays: Tags.
- I. Small-sized Equipment: Tags.
- J. Tanks: Nameplates.
- K. Thermostats: Nameplates.
- L. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- M. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Advanced Graphic Engraving, LLC
 - 2. Brimar Industries, Inc
 - 3. Craftmark Pipe Markers
 - 4. Kolbi Pipe Marker Co
 - 5. Seton Identification Products, a Tricor Direct Company
 - 6. Or Approved Equal
- B. Letter Color: Black.
- C. Letter Height: 1/4 inch.
- D. Background Color: White.
- E. Phenolic: Conform to ASTM D709.

2.03 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving
 - 2. Brady Corporation
 - 3. Brimar Industries, Inc
 - 4. Craftmark Pipe Markers
 - 5. Kolbi Pipe Marker Co
 - 6. Seton Identification Products, a Tricor Company
 - 7. Or Approved Equal
- B. Metal Tags: Aluminum with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges. Use metal tags in return air plenums.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 STENCILS

- A. Manufacturers:
 - 1. Brady Corporation
 - 2. Craftmark Pipe Markers
 - 3. Kolbi Pipe Marker Co
 - 4. Seton Identification Products, a Tricor Company
 - 5. Or Approved Equal
- B. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 - 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
 - 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
 - 6. Ductwork and Equipment: 2-1/2 inch high letters.
 - 7. Stencil Paint: Semi-gloss enamel, colors conforming to ASME A13.1.

2.05 CEILING GRID LABELS

- A. Label each device or valve above the ceiling and label the ceiling grid below each. Indicate the type of device or valve and its associated service (e.g. "Shutoff Valve – HW", "VAV-21").
- B. Provide custom printed labels for each device, either vinyl or polypropylene, suitable for indoor / outdoor applications. Use portable printer equal to Brady HandiMark Portable Industrial Labeling System.
- C. Labels shall be no more than 1-inch in height. Lettering shall be minimum 18-point font. Lettering shall be black on white tape.
- D. Provide a list of devices and valves labeled with the identical information in the O&M Manuals.
- E. Submit samples of markings on three different devices for approval of the Owner and Engineer.
- F. Ceiling grid markers shall be the color listed below:
 - 1. Mechanical Equipment/Fan/Dampers, etc. - Neon Yellow
 - 2. Gas valves/regulators/etc. - Yellow
 - 3. Chilled Water Valves/Low point drains/etc. - Blue

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. All piping and duct shall be labeled at least once in EVERY room. Piping and ductwork shall be labeled every 15 ft and at every change of direction.
- D. All exposed mechanical piping in mechanical rooms, boiler rooms, on and above mezzanine levels, both insulated and uninsulated, shall be color coded with 30 mil PVC jacketing per the following schedule:
 - 1. Chilled Water Supply/Return Medium Blue
 - 2. Makeup Water Green
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Install ductwork with stencilled painting. Identify with air handling unit identification number and area served. Identify service (supply, return, exhaust, outside air, etc.) Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Provide ceiling grid labels to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.
- H. Identify control panels, manual motor starters, combination motor starters, disconnects, variable frequency drives,, and major control components outside panels with plastic nameplates.
- I. Identify thermostats or temperature sensors relating to air handling units or valves with labels.
- J. Identify valves in main and branch piping with valve labels.
- K. Tag automatic controls, instruments, and relays. Key to control schematic.
- L. Identify pumps with plastic nameplates indicating pump number, system served, GPM, and feet of head.
- M. Provide ceiling track markers to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment. Markers shall be installed prior to request for above ceiling inspection.

3.03 SCHEDULE

- A. Standard Color Identification for Mechanical Piping (all labels shall be provided with flow arrows):
 - 1. Chilled Water Supply/Return CHWS/CHWR White Lettering/Blue Background
 - 2. Makeup Water MUW White Lettering/Green Background
 - 3. Condensate Drain COND Black Lettering/White Background
- B. Standard Color Identification for Ductwork (all labels shall be provided with flow arrows):
 - 1. Supply Air SUPPLY Black Lettering
 - 2. Return RETURN Black Lettering
 - 3. Outside Air OUTSIDE AIR Black Lettering
 - 4. General Exhaust EXHAUST Black Lettering
 - 5. Fume Hood Exhaust FUME EXH Black Lettering

END OF SECTION 23 05 53

**SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of hydronic systems.
- B. Measurement of final operating condition of HVAC systems.

1.02 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition 2016.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems 2008, with Errata (2019).
- C. NEBB (TAB) - Procedural Standard for Testing Adjusting and Balancing of Environmental Systems 2019.

1.03 SUBMITTALS

- A. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Architect.
 - 2. Submit to the Commissioning Authority.
- B. Include at least the following in the plan:
 - 1. Indicate standard to be followed (AABC or NEBB)
 - 2. List of all waterflow and system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - 3. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - 4. Identification and types of measurement instruments to be used and their most recent calibration date.
 - 5. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - 6. Final test report forms to be used.
 - 7. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - a. Terminal flow calibration (for each terminal type).
 - b. Diffuser proportioning.
 - c. Branch/submain proportioning.
 - d. Total flow calculations.
 - e. Rechecking.
 - f. Diversity issues.
 - 8. Details of how TOTAL flow will be determined; for example:
 - a. Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
 - 9. Specific procedures that will ensure that systems are operating at the lowest possible pressures and methods to verify this.
 - 10. Time schedule for TAB work to be done in phases (by floor, etc.).
 - 11. Description of TAB work for areas to be built out later, if any.
 - 12. Time schedule for deferred or seasonal TAB work, if specified.
 - 13. False loading of systems to complete TAB work, if specified.
 - 14. Procedures for formal deficiency reports, including scope, frequency and distribution.
- C. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- D. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.

2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 3. Provide final reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations. The Final Report shall be placed in and become a part of the Maintenance and Operations Manuals (4 copies).
 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 6. Units of Measure: Report data in I-P (inch-pound) units only.
 7. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Also include a certification sheet containing the seal and name, address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instruments used for the procedures along with proof of calibration.
- E. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

1.04 QUALITY ASSURANCE

- A. The TAB agency shall be a subcontractor of the General Contractor (or Construction Manager) and shall report directly to and be paid by the General Contractor.
- B. The TAB agency shall be either a certified member of AABC or NEBB to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein.
- C. Any agency that has been the subject of disciplinary action by either the AABC or NEBB within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.
- D. TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the Agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Engineer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by an approved successor.
- E. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
 1. Shall directly supervise all TAB work.
 2. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC, TABB or NEBB.
 3. Would follow all TAB work through its satisfactory completion.
 4. Shall provide final markings of settings of all HVAC adjustment devices.
 5. Permanently mark location of duct test ports.

6. Shall document critical paths from the fan or pump. These critical paths are ones in which are 100% open from the fan or pump to the terminal device. This will show the least amount of restriction is being imposed on the system by the TAB firm.
- F. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing. The lead technician shall be certified by AABC or NEBB

1.05 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee AABC or NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 2. Systems are balanced to optimum performance capabilities within design and installation limits.
 3. Warranty Period: Five (5) years.

PART 2 PRODUCTS

2.01 PLUGS

- A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

2.02 INSULATION REPAIR MATERIAL

- A. Refer to individual insulation sections for repair of insulation removed or damaged during TAB work.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 1. AABC (NSTSB), AABC National Standards for Total System Balance.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 2. Having minimum of three years documented experience.
 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.
- F. For each air handling system, provide a graphical static pressure profile indicating the pressure drop across each component of the air handling unit (filter, coils, dampers, wheel, etc).

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 1. Systems are started and operating in a safe and normal condition.
 2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.
 4. Hydronic systems are flushed, filled, and vented.

5. Pumps are rotating correctly.
 6. Proper strainer baskets are clean and in place.
 7. Service and balance valves are open.
 8. Clean and set automatic fill valves for required system pressure.
 9. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
 10. Check air vents at high points of systems and determine if all are installed to bleed air completely.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
- C. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
- D. Compare design to installed equipment and field installations.
- E. Walk the system to determine variations of installation from design.
- F. Check filters for cleanliness.
- G. Lubricate all motors and bearings.

3.04 ADJUSTMENT TOLERANCES

- A. Water System Tolerances

Systems - Water	Tolerances of Plan Design	Remarks
Coils, Heat Exchangers, Pumps, Evaporators, Condensers	+/- 5%	

3.05 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
- D. Apply instrument as recommended by the manufacturer.
- E. When averaging values, take a sufficient quantity of readings that will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- F. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- G. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- H. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

- I. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- J. Seal ducts and piping, and test for and repair leaks.
- K. Seal insulation to re-establish integrity of vapor barrier.
- L. Retest, adjust, and balance systems subsequent to significant system modifications and resubmit test results.

3.06 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
- G. The TAB report shall indicate the critical circuit, which coils were closed for diversity (if applicable), and how the differential pressure setpoint was established.

3.07 CRITICAL FLOW PATH

- A. Provide a documented critical path for all fluid flows. There shall be at least one terminal device that can be traced back to the fan or pump where there is no damper or valves that are less than 100% open.

3.08 DEMONSTRATION

- A. Training
 - 1. Train the Owner's maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Provide four (4) hours on site training. Review with the Owner's personnel the information contained in the Operating and Maintenance Data specified in Division 1 and Section 23 01 00.
 - 2. Schedule training with the Owner through the Engineer with at least 7 days prior notice.

3.09 SCOPE

- A. Test, adjust, and balance the following:
 - 1. HVAC Pumps.
 - 2. Air Cooled Water Chillers.
 - 3. Air Coils.
- B. This Section does NOT include:
 - 1. Testing boilers and pressure vessels for compliance with safety codes.
 - 2. Specifications for materials for patching mechanical systems.
 - 3. Specifications for materials and installation of adjusting and balancing; refer to the respective system sections for materials and installation requirements.
 - 4. Requirements and procedures for piping and ductwork systems leakage tests.

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer.
 - 2. Model/Frame.
 - 3. HP/BHP.

4. Phase, voltage, amperage; nameplate, actual, no load.
 5. RPM.
 6. Service factor.
 7. Starter size, rating, heater elements.
 8. Sheave Make/Size/Bore.
- B. V-Belt Drives:
1. Identification/location.
 2. Required driven RPM.
 3. Driven sheave, diameter and RPM.
 4. Belt, size and quantity.
 5. Motor sheave diameter and RPM.
 6. Center to center distance, maximum, minimum, and actual.
- C. Pumps:
1. Identification/number.
 2. Manufacturer.
 3. Size/model.
 4. Impeller.
 5. Design flow rate, pressure drop, BHP.
 6. Actual flow rate, pressure drop, BHP.
 7. Discharge pressure.
 8. Suction pressure.
 9. Total operating head pressure.
 10. Shut off, discharge and suction pressures.
 11. Shut off, total head pressure.
- D. Chillers:
1. Identification/number.
 2. Manufacturer.
 3. Capacity.
 4. Model number.
 5. Evaporator entering water temperature, design and actual.
 6. Evaporator leaving water temperature, design and actual.
 7. Evaporator pressure drop, design and actual.
 8. Evaporator water flow rate, design and actual.
- E. Cooling Coils:
1. Identification/number.
 2. Location.
 3. Manufacturer.
 4. Air flow, design and actual.
 5. Entering air DB temperature, design and actual.
 6. Entering air WB temperature, design and actual.
 7. Leaving air DB temperature, design and actual.
 8. Leaving air WB temperature, design and actual.
 9. Water flow, design and actual.
 10. Water pressure drop, design and actual.
 11. Entering water temperature, design and actual.
 12. Leaving water temperature, design and actual.
 13. Air pressure drop, design and actual.

END OF SECTION 23 05 93

SECTION 23 07 16 HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment insulation.
- B. Jacketing and accessories.

1.02 REFERENCE STANDARDS

- A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021a.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).
- C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).
- D. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement 2007 (Reapproved 2019).
- E. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- F. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation 2017 (Reapproved 2023).
- G. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.
- H. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- I. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2022a.
- J. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).
- K. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation 2021.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
- M. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- N. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth 2016b.
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.
- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.
- C. Provide plates from MICA 8th edition manual for each insulation system on the project as part of the submittals. The plates for each system shall be filled out by the insulating contractor for each product being used.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.

- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum five years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturers:
 - 1. CertainTeed Corporation
 - 2. Johns Manville Corporation
 - 3. Knauf Insulation
 - 4. Owens Corning Corp
 - 5. Or Approved Equal
- B. Insulation: ASTM C553; flexible, noncombustible.
 - 1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 2. Secure with outward clinch expanding staples and vapor barrier mastic.
- D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.
- F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. CertainTeed Corporation
 - 2. Johns Manville Corporation
 - 3. Knauf Insulation
 - 4. Owens Corning Corp
 - 5. Or Approved Equal
- B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
 - 1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 - 4. Maximum Density: 8.0 pcf.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.

- 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
- D. Facing: 1 inch galvanized steel hexagonal wire mesh stitched on one face of insulation.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.
- F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.04 HYDROUS CALCIUM SILICATE

- A. Insulation: ASTM C533; rigid molded, asbestos free, gold color.
 - 1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 1200 degrees F.
 - 3. Density: 15 pcf.
- B. Tie Wire: 0.048 inches stainless steel with twisted ends on maximum 12 inch centers.
- C. Insulating Cement: ASTM C449.

2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Aeroflex USA, Inc
 - 2. Armacell LLC
 - 3. K-Flex USA LLC
 - 4. Or Approved Equal
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.06 JACKETING AND ACCESSORIES

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire-retardant lagging adhesive.
 - 1. Lagging Adhesive: Compatible with insulation.
- B. Aluminum Jacket:
 - 1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 - 2. Thickness: 0.016 inch sheet.
 - 3. Finish: Embossed.
 - 4. Joining: Longitudinal slip joints and 2 inch laps.
 - 5. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
 - 6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
- C. Reinforced Tape:
 - 1. Metallized polypropylene tape suitable for continuous spiral wrapping of insulated pipe bends and fittings resulting in a tight, smooth surface without wrinkles.
 - 2. Comply with UL 723, SAE AMS3779, and ASTM C1423.
 - 3. Finish: Match insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

- B. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- C. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- D. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- E. Insulated equipment containing fluids below ambient temperature; insulate entire system.
- F. Inserts and Shields:
 - 1. Shields: Galvanized steel between hangers and inserts.
 - 2. Insert Location: Between support shield and equipment and under the finish jacket.
 - 3. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 4. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- G. Finish insulation at supports, protrusions, and interruptions.
- H. Equipment in Mechanical Equipment Rooms: Finish with canvas jacket sized for finish painting.
- I. Exterior Applications:
 - 1. Provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement.
 - 2. Cover with aluminum jacket.
- J. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.
- K. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- L. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

3.03 SCHEDULE

- A. Cooling Systems: 1-1/2 inch elastomeric foam insulation. For exterior applications, 2 inch insulation.
 - 1. Pump Bodies
 - 2. Air Separators
 - 3. Expansion Tanks
 - 4. Chiller Cold Surfaces (Not Factory Insulated)
 - 5. Equipment Exposed to Freezing with Heat Tracing

END OF SECTION 23 07 16

SECTION 23 07 19 HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jacketing and accessories.
- D. Section 07 84 00 - Firestopping.

1.02 REFERENCE STANDARDS

- A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021a.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).
- C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement 2007 (Reapproved 2019).
- D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- E. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation 2017 (Reapproved 2023).
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.
- G. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation 2022.
- H. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2018).
- I. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation 2023.
- J. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation 2021.
- K. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics 2019.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
- M. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- N. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials 2013 (Reapproved 2021).
- O. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth 2016b.
- P. MICA - Midwest Insulation Contractors Association National Commercial & Industrial Insulation Standards; 8th Edition.
- Q. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations. Provide the following information:
 - 1. Schedule indicating insulation type, thickness, and location for each service (equipment, duct, and pipe with size).
 - 2. Density

3. Compressive Strength
 4. "k" value at 75 deg F
 5. Nominal "R" value
 6. Mean temperature range
 7. Flame spread rating
- B. Shop Drawings: Show details for the following:
1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 2. Attachment and covering of heat tracing inside insulation.
 3. Insulation application at pipe expansion joints for each type of insulation.
 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 5. Application of field-applied jackets.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.
- D. Provide plates from MICA 8th edition manual for each insulation system on the project as part of the submittals. The plates for each system shall be filled out by the insulating contractor for each product being used.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum five years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
- B. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

1.06 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.
- C. Insulation shall not be installed until all testing and inspection of pipe, duct, vessel, etc. has been completed and approved by Engineer/Owner's representative.
- D. Replace insulation damaged by either moisture or other means. Insulation which has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also replace any materials damaged by the condensation.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, UL 723, UL 723, or ASTM E84.

2.02 HYDROUS CALCIUM SILICATE

- A. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.
1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 2. Maximum Service Temperature: 1200 degrees F.
 3. Density: 15 pcf.
- B. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- C. Insulating Cement: ASTM C449.

2.03 PHENOLIC CLOSED CELL

- A. Manufacturers:
 - 1. ITW Trymer Supercel
 - 2. Dyplast
 - 3. PolyPhen
 - 4. Resolco Insulphen
 - 5. Or Approved Equal
- B. Insulation Material: ASTM C1126, rigid foam. 3.75 PCF.
 - 1. K Value: 0.18 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Minimum Service Temperature: Minus 70 degrees F.
 - 3. Maximum Service Temperature: 250 degrees F.
 - 4. Water Absorption: 0.5 percent by volume, maximum, when tested in accordance with ASTM D2842.
 - 5. ASTM E96. Moisture Vapor Transmission: 4.0 perm inch.
 - 6. Connection: Waterproof vapor barrier adhesive.
 - a. Vapor Barrier Manufacturers:
 - 1) Polyguard ZeroPerm
 - 2) Polyguard Insulrap
 - 3) Childers
 - 4) Foster

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Aeroflex USA, Inc
 - 2. Armacell LLC
 - 3. K-Flex USA LLC
 - 4. Or Approved Equal
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.05 JACKETING AND ACCESSORIES

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire-retardant lagging adhesive.
 - 1. Lagging Adhesive: Compatible with insulation.
 - a. Manufacturers:
 - 1) Vimasco Corporation:
 - 2) GLT Products
- B. Aluminum Jacket:
 - 1. Manufacturers:
 - a. Alumaguard.
 - b. ITW.
 - 2. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 - 3. Thickness: 0.016 inch sheet.
 - 4. Finish: Embossed.
 - 5. Joining: Longitudinal slip joints and 2 inch laps.
 - 6. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
 - 7. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
- C. Reinforced Tape:

1. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
 2. Comply with UL 723, ASTM E84.
 3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.
 4. Finish: Match insulation.
- D. Plain Foil Tape:
1. Aluminum foil with pressure-sensitive adhesive on paper release liner.
 2. Finish: Plain foil.
- E. Vapor Barrier Membranes: ASTM C1136, Type IX.
1. Multilayer Laminate Vapor Barrier:
 - a. Provide multilayer laminate with 1.0 mil, 0.001 inch foil, reversible.
 - b. Thickness: 2.4 mil, 0.002 inch.
 - c. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions and the MICA manual 8th edition. In cases of conflict, the more stringent instructions shall apply.
- B. Where existing piping insulation is either removed or damaged during construction, it shall be reinsulated per these specifications.
- C. Where insulation thickness exceeds 3 inches, the insulation shall be two layers. Secure first layer before installing the next layer and stagger the joints.
- D. Install multiple layers of insulation with longitudinal and end seams staggered.
- E. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- F. Install insulation with least number of joints practical.
- G. Exposed Piping: Locate insulation and cover seams in least visible locations.
- H. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
 2. Insulation on all pipes or ducts conveying air or liquids below the ambient temperature is required to have a continuous vapor barrier. On all insulation with a vapor barrier, seal the joints, duct wrap seams, vapor retarder (ASJ) film seams and penetrations in insulation at hangers, supports, anchors, and other projections with a vapor-barrier coating/mastic as specified in the individual insulation sections.
 3. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier coating/mastic.
 4. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 5. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- I. Inserts and Shields:

1. Shields: Galvanized steel, 20 gauge, one half the circumference of the insulation, and a minimum of 12 inches long, between pipe hangers or pipe hanger rolls and inserts.
 2. Insert location: Between support shield and piping and under the finish jacket.
 3. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 4. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.
- K. Pipe Exposed in Mechanical Rooms and Finished Spaces: Finish with canvas jacket sized for finish painting. Canvas shall be coated twice with Foster fireproof lagging to ensure specified flame and smoke spread ratings.
- L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Provide with 0.016 inch aluminum rolled jacket. Cover with aluminum jacket with aluminum bands 12 inches on center and at each butt joint located on bottom side of horizontal piping. Fittings shall be covered with two piece factory fabricated "ELL-JACS."
- M. Heat Traced Piping: All piping exposed outdoors shall be wrapped with electric trace before insulation is applied. Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- N. All exposed piping surfaces, insulation, supports, etc., shall be painted with two coats of oil base paint. Color shall be selected by the Owner.
- O. Insulation systems shall be installed per the applicable plate from the MICA manual 8th edition:
1. Pre-formed Pipe Insulation Single Layer Construction: Plate 1-100
 2. Flexible Foam Insulation: Plate 1-200
 3. Field applied Metal Jacketing: Plate 1-400
 4. Non-metallic sealed jacketing systems: PVC, etc: Plate 1-510
 5. Split Ring Hangers: Plate 1-600
 6. Clevis Hanger with High Density Inserts: Plate 1-610
 7. Pre-Insulated Pipe Support, Standoff Clamp: Plate 1-640
 8. Vapor Stop (Dam) - Pipe: Plate 1-660
 9. Refrigerant and Low Temperature: Plate 1-801
 10. Traced Piping: Plate 1-900
 11. Pre-formed Elbow Insulation: Plate 2-100
 12. Mechanical Fitting Field Fabricated: Plate 2-116
 13. Pre-formed or Fabricated Tee Insulation: Plate 2-120
 14. Field or Factory-Fabricated Valve Insulation: Plate 2-130
 15. In-line Flange Insulation Built-up and Beveled: Plate 2-135
 16. Flexible Foam Fittings: 90s and 45s: Plate 2-200
 17. Flexible Foam Fittings, Ts: 2-220
 18. Flexible Foam Ts: Plate 2-225
 19. Non-metallic Jackets: Fitting and Valve Insulation Sealed Jacketing Systems: Plate 2-536
 20. Vapor Stop (Dam) - Fittings: Plate 2-660
 21. Large Diameter Vessels Block and Blanket Insulation: Plate 4-100
 22. Small Diameter Vessels: Plate 4-120
 23. Flexible Foam for Low Temperature Equipment: 4-210

3.03 SCHEDULE

- A. Chilled Water:
1. All interior piping 1.5 inches and smaller shall have minimum 1.5 inch thick insulation.
 2. All interior piping 2.0 inches and larger shall have 2.0 inch thick insulation.

3. Piping installed in Boiler, Chiller, Mechanical Rooms, and outside of the building shall have minimum 2.0 inch thick insulation. Insulation on all mezzanine and platform piping shall have minimum 2.0 inch thick insulation.
 4. Chilled water piping insulation shall be closed-cell rigid phenolic foam type.
- B. Condensate
1. Condensate lines shall be insulated with 1.0 inch thick closed cell insulation. The insulation shall extend from the connection on the unit until it either terminates at a floor drain or other indirect waste receptor, or turns underground.
- C. Refrigerant
1. Refrigerant lines shall be insulated with 1.5 inch thick closed cell elastomeric foam insulation. Both gas and liquid lines should be insulated.

END OF SECTION 23 07 19

**SECTION 23 09 00
DIRECT DIGITAL CONTROL SYSTEM**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Direct Digital Control System, using electric/electronic actuators for control of the following equipment where provided:
 - 1. Chilled Water System.

1.02 REFERENCES

- A. ASHRAE Standard 62 - Ventilation for Acceptable Indoor Air Quality.
- B. ASHRAE SSPC 135 - ASHRAE Standing Standard Project Committee 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks.

1.03 DESIGN / PERFORMANCE REQUIREMENTS

- A. Scope of work is to integrate new chiller and pumps into the Owner's existing BAS, develop schedules for control, and update all existing graphics.
- B. Description - This specification for a Building Automation System (BAS) as detailed herein shall be strictly enforced. Provide additions and extensions to the existing Building Automation System (BAS) incorporating BACnet Testing Laboratories (BTL) certified BACnet devices communicating over a Master-Slave Token Passing (MSTP) network at the field level and Niagara4 network operating system at the network TCP/IP level. The Niagara4 based network managers shall bridge the BACnet/MSTP field communications network to the owner's Local and/or Wide Area Network, as designated by the owner, and shall communicate seamlessly with the other Niagara4 based devices on the owner's BAS network. The BAS shall consist of Direct Digital Control (DDC) controllers, Building Controllers (BC), network management tools, programming tools, web browser based Graphical User Interface, sensors, relays, valves, actuators, and other equipment as may be necessary to provide for a complete and operational control system for the HVAC and other building related systems as described within these specifications.
- C. The system installed shall seamlessly connect devices other than HVAC throughout the building regardless of subsystem type, i.e. HVAC, lighting, and power systems devices should easily coexist on the same network channel without the need for gateways. BACnet components not supplied by the primary manufacturer of the BAS shall be integrated to share common software for network communications, time scheduling, alarm handling, and history logging.
- D. The documentation contained in this section and other contract documents pertaining to HVAC Controls is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions shown or as implied in the contract documents.
- E. System configuration and monitoring shall be performed via a PC-type computer. Under no circumstances shall the PC be used as a control device for the network. It can be used for storage of data.

1.04 OPEN SYSTEMS DESIGN

- A. It is the owner's expressed goal to implement an open Building Automation System that will allow products from different manufacturers and/or suppliers to be integrated into a single unified system in order to provide flexibility for expansion, maintenance, and service of the system. The BAS provided shall maintain open interoperability in the following areas.
- B. Communications - Provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, LonWorks technology, MODBUS, OPC, and other open communication protocols in one open, interoperable system. Where existing systems using proprietary protocols exist, a gateway or driver may be incorporated to provide for interoperability.
- C. Network Management - Network management tools shall be based upon Niagara 4 technology as developed by the Tridium Corporation. All tools and hardware provided shall comply with the current release of the Niagara 4 platform.

- D. User Access - The supplied system must incorporate the ability to access all data using standard Web browsers without requiring a proprietary operator/user interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access.
- E. Databases - All network databases shall be provided in a Niagara 4 format. The database shall be stored on the owner PC and provide on a separate CD upon final acceptance of the project. An updated database shall be provided on a CD at the end of the warranty period.
- F. Building Controllers (BC) - All BCs (devices that provide for communication between the field level controllers and the owner's wide and/or local area network, and manage facility global functions such as alarms, trends, schedules and normalization of data) shall conform to the current release of the Niagara4 platform. The number of BACnet nodes (controllers) attached to any Niagara4 based network manager shall not exceed 100.
- G. Regardless of the maximum number of nodes indicated above, it is ultimately the exclusive responsibility of the systems integrator/building controls contractor to ensure that the BC has adequate resources for the number of nodes (controllers) attached to it.
- H. Niagara4 Network Manager Server software shall be furnished and installed on a server grade PC for applications requiring two or more network managers. Engineers Note: Delete this section if there is an existing Niagara4 Network Manager.
- I. Direct Digital Controllers (DDC) - All DDC devices for HVAC and lighting control, with the exception of DDC device furnished as part of the OEM control package, shall be provided by one manufacturer and shall be certified to the current BTL standards appropriate to their application provided an appropriate BTL Certification standard exist. All points within a controller including hard I/O and software based points shall be available for viewing, management, and manipulation through the Niagara4 platform tools.
- J. Product Access - All products provided shall be available for sell directly to the owner or is designated agent from multiple sources without restrictions on territory. A list of at least 3 purchasing sources shall be provided as part of the BAS submittals.
- K. Software Tools - All software tools needed for full functional use, including programming of BCs and DDC, network management and expansion, and graphical user interface development, of the BAS described within these specifications, shall be provided to the owner or his designated agent. Any licensing required by the manufacturer now and into the future, including changes to the licensee of the software tools and the addition of hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and servicing shall be provided. Any such changes to the designated license holders shall be made by the manufacturer upon written request by the owner or his agent. Any cost associated with the license changes shall be identified within the BAS submittals.
- L. Programming Tools - Provide freely available Niagara4 compatible device programming tools to facilitate the programming and configuration of all of the DDC devices that are provided for the HVAC and lighting control. Device programming tools shall be provided free of charge and be compatible with the current published versions of the network management tool that is provided as part of this project. These programming tools shall be compatible with all other brands of the Niagara4 platform network management tools. The SI shall demonstrate as part of their prequalification as to how they intend to comply with these requirements.
- M. Software License Agreement - The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights as it relates to disclosure of trade secrets contained within said software. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code, databases and documentation for all configuration and programming that is generated for a given project and/or

configured for use with the BC, BAS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.

- N. The System Integrator shall provide as part of the submittals a copy of the Niagara4 Compatibility Statement (NiCS) verifying that all aspect of the Niagara4 platform as provided maintain an Open System Design. The System as provided shall confirm with the following NiCS

Property	Value
STATION COMPATIBILITY IN	All
STATION COMPATIBILITY OUT	All
TOOL COMPATIBILITY IN	All
TOOL COMPATIBILITY OUT	All

O. TRAINING

1. Manufacturer provided training on the use and operation of all products provided within these specifications shall be available for purchase and attendance by the owner or his designated agent. Such training shall be of the same curriculum as the training courses provided by the manufacturer to the system integrator. A list of training courses and the associated cost shall be provided as part of the bas submittals.

1.05 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 1. Dimensions, capacities, performance characteristics, electrical requirements, and material finishes.
 2. Storage and handling requirements and recommendations.
 3. Preparation instructions and recommendations.
 4. Installation and start-up methods.
- B. Shop Drawings:
 1. Network Block Diagrams or System Riser Diagrams depicting all DDC components that makes up the network. Include specific detail on network terminations, and panel power requirements, stating where the DDC panels are to be powered from and the equipment that it is controlling for each DDC panel within the diagram.
 2. Point-to-point Termination Detail drawings for each unique control application type. Drawings that are typical of one another shall state the quantity that they represent, and the specifics for each including all wiring and piping required to install and operate the system. For terminations that are unknown at the time of submittal, properly designate these as "Field determined terminations," and include in the As-built Drawings after completion. All wiring and piping shall be either number or color-coded on the drawings.
 3. Provide damper and valve schedules showing sizes, characteristics, model numbers, and specific locations.
 4. Prefabricated control panels drawings with panel interior and exterior layout details depicting the equipment layout and panel wiring and piping details.
 5. Color Graphics Flow Chart showing the graphic screen layouts and the manner in which the screens are to be linked. Include the actual screen layout, point information locations, and samples of colors typically used.
 6. Include detailed information on the point naming convention to be used. Provide documentation on all sequences of operation that cannot be performed by stand-alone controls, and require high-level programs to be created.
- C. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- D. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic checking and adjustment of system and periodic cleaning and maintenance of all components.

- E. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Submit all data specified in "Submittals" in final "Record Documents" form.
- F. Operation and Maintenance Data: Provide operation and maintenance data as a manual that is properly organized and tabbed in a suitable binder.
 - 1. Interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Setpoint adjustment and scheduling modifications.
 - 4. Operation and sequencing instructions of control loops for all mechanical equipment being controlled
 - 5. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Manufacturers Field Representation: Field representative that has been trained in the installation, programming, and commissioning of the equipment specified and in the direct employ of the Controls Manufacturer and be factory trained.
- C. Installer Qualifications: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

1.08 WARRANTY

- A. Provide a two year warranty on all DDC controllers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer(s):
 - 1. ABB (Cylon) by Envirocon - Preferred Alternate
 - 2. Reliable
 - 3. JCI

2.02 DIRECT DIGITAL CONTROL SYSTEM

- A. General: Provide a Building Automation System (BAS) system that utilizes the BACnet communications protocol conforming to ASHRAE SSPC 135. The system must also support high-speed 10 Mb/s Novell or IP Ethernet communications

2.03 NETWORK MANAGEMENT AND GRAPHICAL USER INTERFACE

- A. Network Controller (NC): Provide Network Area Controllers (NC) for all equipment to be controlled as indicated on the Drawings and the sequence of operation specified in Section 23 09 93 - Sequence of Operations for HVAC Controls.
 - 1. Network Controllers (NC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
 - a. Calendar functions.
 - b. Scheduling
 - c. Trending
 - d. Alarm monitoring and routing with alarm recording and historical archiving
 - e. Time synchronization via internet time servers utilizing NTP methodology.
 - f. Integration of BACnet controller data.

2. Network Area Controller must provide the following minimum hardware features:
 - a. TI AM3352: 1000MHz ARM® Cortex™-A8
 - b. 1GB DDR3 SDRAM
 - c. Removable Micro SD Card with minimum 4 GB Storage
 - d. Wi-Fi (Client or WAP)
 - 1) IEEE802.11a/b/g/n
 - 2) IEEE802.11n HT20 @ 2.4GHz
 - 3) IEEE802.11n HT20/HT40 @ 5GHz
 - 4) Configurable radio (Off, WAP, or Client)
 - 5) WPAPSK / WPA2PSK supported
 - e. USB Type A Input
 - f. Two Ethernet Ports - 10/100 Mbps
 - g. One RS-232 port
 - h. Two RS-485 ports
 - i. Real-time Clock
 - j. Battery-less Backup
 - k. Secure boot
 - l. 24 VAC/DC Power Supply
 - m. Capable of operation over a temperature range of 32 to 122 degrees F.
 - n. Capable of operation over a humidity range of 0 to 80 percent RH, non-condensing
3. NC shall support standard Web browser access via the Intranet/Internet.
4. Event Alarm Notification and actions:
 - a. NC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - b. NC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via a wide-area network.
 - c. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - 1) To alarm.
 - 2) Return to normal.
 - 3) To fault.
 - d. Provide for the creation of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 - e. Provide timed (schedule) routing of alarms by class, object, group, or node.
 - f. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. User shall be able to reset runtime or event count values with appropriate password control.
5. Control equipment and network failures shall be treated as alarms and annunciated.
6. Alarms shall be annunciated in any of the following manners as defined by the user:
 - a. Screen message text.
 - b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - 1) Day of week.
 - 2) Time of day.
 - 3) Recipient.
 - c. Graphic with flashing alarm object(s).
 - d. Twitter notification.
 - e. RSS feeds.
7. The following shall be recorded by the NC for each alarm (at a minimum):
 - a. Time and date.
 - b. Location (building, floor, zone, office number, etc.).
 - c. Equipment (air handler #, VAV, etc.).
 - d. End device (Temp sensor, smoke detector, etc.).
 - e. Acknowledge time, date, and user who issued acknowledgement.

8. Alarm actions may be initiated by user defined programmable objects created for that purpose.
 9. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
 10. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
 11. Provide a "query" feature to allow review of specific alarms by user defined parameters.
 12. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
 13. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
- B. Data Collection and Storage: NC shall have the ability to collect data for any property of any object and store this data for future use.
1. Data collection shall be performed by log elements, resident in the NAC that has, at a minimum, the following configurable properties:
 - a. Designating the log as interval or deviation.
 - b. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - d. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
 2. All log data shall be stored in a relational SQL database in the NC and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.
 3. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
 4. All log data shall be available to the user on-demand, or on scheduled intervals in the following data formats:
 - a. HTML5.
 - b. XML.
 - c. Plain Text.
 - d. Comma or tab separated values.
 - e. PDF.
 - f. Excel.
 5. Systems unable to provide log data in PDF and Excel formats at a minimum shall not be acceptable.
 6. NC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NC on the network. Provide the ability to configure the following archiving properties, at a minimum.
 - a. Archive on time of day.
 - b. Archive on user-defined number of data stores in the log (buffer size).
 - c. Archive when log has reached its user-defined capacity of data stores.
 - d. Provide ability to clear logs once archived.
- C. Database Backup and Storage: NC shall have the ability to automatically backup its database. Database shall be backed up based on a user-defined time interval.
1. Copies of the current database and the most recently saved database shall be stored in the NC. The age of the most recently saved database is dependent on the user-defined database save interval.
 2. NC database shall be stored, at a minimum, in SQL format to allow for user viewing and editing, if desired.

- D. Web Browser Clients: System shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer, Mozilla Firefox, Google Chrome and Apple Safari. Systems requiring proprietary software to enable a standard Web browser to be resident on the client machine. Manufacture-specific browsers will not be acceptable. To ensure site security for web-enabled browsing, plug-ins requiring the use of Active-X or Flash technology are not acceptable.
1. Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable.
 2. Web browser shall provide the view of the system, in terms of graphics, schedules, calendars, logs, etc.
 3. Web browser client shall support at a minimum, the following functions:
 - a. HTML5 representation of graphics
 - b. User log-on identification and password shall be required. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented. .
 - c. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - d. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - e. Storage of the graphical screens shall be in the Network Controller (NC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - f. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
 - g. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - 1) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - 2) View logs and charts.
 - 3) View and acknowledge alarms.
 - 4) Setup and execute SQL queries on log and archive information.
 - h. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.
- E. System Programming: Graphical User Interface software (GUI) shall utilize graphics in an HTML5 format. JAVA based graphics are not acceptable. The ability to perform system programming and graphic display engineering as part of a complete software package.
1. Provide a library of control, application, and HTML5 graphic objects to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
 2. Programming Methods:
 - a. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to

- other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.
- b. Configuration of each object will be done through the object's property panel using fill-in the blank fields, list boxes, and selection buttons. Use of manufacturer-specific procedural language for configuration will not be accepted.
 - c. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
 - d. System shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.
- F. Object Libraries: Provide a standard library of objects for development and setup of application logic, user interface displays, system services, and communication networks.
1. Objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
 2. In addition to the standard libraries specified here, the manufacturer shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.
 3. All control objects shall conform to the control objects specified in the BACnet specification.
 4. The object library shall include objects to support the integration of devices connected to the Network Controller (NC). At a minimum, provide the following as part of the standard library included with the programming software:
 - a. For BACnet devices, provide the following objects at a minimum:
 - 1) Analog In
 - 2) Analog Out
 - 3) Analog Value
 - 4) Binary <- Delete
 - 5) Binary In
 - 6) Binary Out
 - 7) Binary Value
 - 8) Multi-State In
 - 9) Multi-State Out
 - 10) Multi-State Value
 - 11) Schedule Export
 - 12) Calendar Export
 - 13) Device
 - b. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
 - c. For BACnet devices, provide the following support at a minimum:
 - 1) Read Property
 - 2) Read Property Multiple
 - 3) Write Property
 - 4) Write Property Multiple
 - 5) Who-has
 - 6) I-have
 - 7) Who-is
 - 8) I-am
 - 9) Ethernet
 - 10) BACnet IP Annex J
 - 11) MSTP
 - 12) BACnet Broadcast Management Device (BBMD) function

- 13) Foreign Device Registrar
- 14) Routing
- 15) BACnet NAT Based Routing <- Spec Buster, we are the only ones doing that offer a front end. Some companied have this feature but only in their routers.

2.04 FULLY PROGRAMMABLE PLANT AND PRIMARY EQUIPMENT CONTROLLERS

- A. Plant and Primary Equipment Controllers (PC) - A BTL listed BACnet controller designed for more complex sequences of operations shall be provided for all primary equipment including, but not limited to built up air handling units, central plant operations, electrical monitoring/metering, and control and management for chillers, boilers and generators. The PCs are to allow for complete flexibility of custom control programming utilizing a graphical object oriented graphical programming tool. Products that utilize alpha numeric "line" programming shall not be allowed. All PCs shall utilize UniPut™ technology, meaning that a minimum of one third of the PC's total input-output point capacity shall be software configurable as any type of digital input (with the exception of pulse inputs), any type of analog input, , any type of digital output, and/or any type of analog output. The PC shall be built on a modern web-based architecture, with a wide application scope with the flexibility of being stand-alone or network enabled.
1. Each PC shall have a minimum of 64K of Non-volatile Flash memory for control applications and 128K non-volatile flash memory for storage with a minimum 32 bit processor. The PC shall have a minimum ambient operating temperature range of -0oC to 70oC or 32oF to 158oF.
 2. Inputs - Analog inputs shall have the following minimum level of performance: 16-bit A to D resolution; allow monitoring of platinum 100 ohms, platinum 1000 ohm, nickel 1000 ohms, thermistor 10K type II, thermistor 10K type III, voltage input 0-10VDC, current input 4-20mA, digital input, pulsed input minimum 2 Hz.
 3. Outputs - Outputs shall be either software configurable to be either analog or digital or dedicated digital only - Analog outputs shall be selectable as voltage of 0-10 VDC (linear) or 4-20mA or Digital outputs shall be 0-12 VDC (off/on), floating or PWM. Outputs shall have an adjustable range of 2 seconds to 15 minutes. Output Resolution shall be a minimum 10 bit digital / analog converter. All individual outputs and power
 4. UniPuts™ - Software configurable as a 0-10V analog input 10V @ 40K Ohm 10 bit resolution, 0-10V analog output 10V @ 20 mA max load, digital volt free contact @ 25 mA continuous, and 24 VAC detect
 5. Provide onboard network communication jacks
 6. The PC shall be provided with a RS232 @ 1K2, 2K4, 9K6, 19K2 or 38K4 (default) Baud
 7. BACnet MS/TP Fieldbus port RS485 @ 9K6,19K2, 38K4 or 76K8 Baud
 8. Port for dedicated handheld tool
 9. RJ11 port
 10. Processor shall be Hitachi (Renasas) SuperH SH17034 32-bit RISC
 11. Minimum Clock Speed 20 MHz
 12. Internal diagnostics
 13. Ability to store device program/strategy on PC
 14. On board scheduling with a minimum of 10 separate schedules
 15. On board data logging/trending
 16. User Programmable Memory Battery backed for 2 years minimum
 17. LCD Interface - The LCD shall come standard with a keypad operator interface that provides real-time access to monitored inputs, setpoints, modes, values, statuses, and outputs.
 - a. The operator interface shall consist of :
 - b. A text-based, interactive backlit display.
 - c. Navigable menus to display, select, edit, and modify values and other controller information.
 - d. List-based menus with a minimum of four (4) lines of text with 20 characters.
 - e. A Real Time Clock with a minimum 2-year battery.
 - f. The operator interface shall, at a minimum, have the following functions:
 - g. Points. The operator interface shall provide points list menus to view the inputs, setpoints, and output values such as hardware inputs/outputs, analog values, binary

- values, multistate values, Intelligent Space Sensor (ISS) inputs, and wireless inputs.
 - h. The points list menus shall allow the operator to monitor, set, and override controller points and values.
 - i. Alarms. The operator interface shall provide a controller's alarms menu to view details of an alarm, to acknowledge the alarm, and to view the alarm history.
 - j. The alarm menu shall allow the operator to view the following type of alarms: active not acknowledged, active acknowledged, and inactive not acknowledged.
 - k. Overrides. The operator interface shall provide an overrides menu to view a list of the controller's overridden points such as hardware input, hardware output, value, constant, or variable. The menu shall allow the operator to select an overridden point and to modify or release the override on the selected point.
 - l. Password protected. The controller operator interface shall provide multi-level password protection, with user-defined, alphanumeric, name/password combinations. The operator interface shall return to lock mode after a user-defined log-off delay. Settings. The operator interface shall provide a settings menu to view and configure date and time parameters such as the current time, time zone, and daylight savings time.
18. Enclosures - Provide separately a plastic enclosure with a separate back plate with terminals such that the electronic portion of the controller can be easily removed for ease of installation and servicing.

PART 3 FIELD DEVICES

3.01 ACTUATORS:

- A. Pneumatic: Pneumatic damper actuators shall be acceptable when fitted with the before-mentioned current pressure transducer and pilot positioner or any other appurtenances, provides adequate torque to meet the application.
- B. Electronic:
- C. Electronic actuators shall be acceptable if proposed model is driven directly by either 4-20 mA or 0-10VDC, requires low voltage supply power (30VAC/VDC or less), and provides adequate torque to meet the application.
- D. Electronic actuators shall be direct-coupled type, manufactured by Belimo Air Controls.
- E. Enclosures:
- F. Enclosures shall be NEMA-1 rated steel, finished to control oxidation in a highly humid atmosphere.
- G. Each enclosure shall have a hinged door with handle and keyed lock.

3.02 CONTROL VALVES

- A. Provide factory fabricated control valves with operators as required by this specification. Provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with specified maximum pressure drop across control valve. Equipment control valves with heavy duty actuators, with proper shut off rating for each individual application.
- B. Water Service Valves: Equal percentage characteristics for throttling service, linear characteristics for three-way mixing or diverting service, with a range of 30 to 1, and maximum full flow pressure drop of 5 psig. (Not less than 3 psig; not more than 7 psig). Two-position valves shall be line size.
- C. Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
- D. Valve Trim and Stems: Polished stainless steel.
- E. Packing: Spring-loaded Teflon, self-adjusting.
- F. Bodies, 2 inches and Smaller: Bronze with screwed end connections, replaceable brass seat. 125 psig rated, minimum.
- G. Bodies, 2-1/2 inches and Larger: Cast iron with flanged end connections, replaceable brass seat. 125 psig rated, minimum.

- H. Butterfly Valves: Butterfly valves may be used for two-position or three-way mixing or diverting service for water applications 6 inch size and larger, provided valve pressure and temperature limitations are not exceeded by maximum pressures and temperatures in the piping system.
- I. Refer to Section 23 05 23 - General-Duty Valves for HVAC Piping Valves for butterfly valve requirements.
- J. Ball-style body automatic control valves shall adhere to the following:
 - 1. NPS 4 and Smaller: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, NPT female end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a Tefzel flow characterizing disc.
 - 2. Sizing:
 - a. Two-Position: Line size or size using a pressure differential of 1 psi.
 - b. 2-way Modulating: 5 psig or twice the load pressure drop, whichever is greater.
 - c. 3-way Modulating: Twice the load pressure drop, but not more than 5 psig.
 - 3. Close-off Pressure Rating: 100 psi. [NPS 3/4" and Smaller for Terminal Units: 200 psi.]
 - 4. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on a four-way DIN mounting-base.
 - 5. All control ball valves shall feature characterized flow guides when used for modulating applications.

PART 4 EXECUTION

4.01 EXAMINATION

- A. Do not begin installation until conditions have been properly prepared.
- B. Verify conditioned power supply is available to control units and to operator workstation.
- C. Verify field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.
- D. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

4.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions. Install electrical material and installation in accordance with appropriate requirements of Division 16.
- B. Wiring: Install conduit and electrical wiring in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - 1. Power wiring required for controllers and control panels shall be dedicated properly fused power circuits for the express use of the individual controller or control panel.
 - 2. Power wiring required for the NAC shall also be dedicated properly fused power circuits for the express use of the NAC, and if available to an emergency power circuit.
 - 3. Install all line voltage wiring in EMT conduit.
 - 4. Install all low voltage wiring within EMT conduit, except when run in ceiling spaces. Low voltage wiring installed in ceiling spaces must be plenum rated wiring in accordance with local codes. All wiring in ceiling spaces must be properly supported to the building so as not to droop. Install wiring as close to the deck as possible to avoid damage from other trades or materials.
 - 5. Install all conduit and wiring in parallel lines to the building structure, corridors, and hallways.
 - 6. Communication wiring shall be installed using shielded cable. The communication network wiring shall be clearly marked with a specific color code. Communication wiring shall not be installed near noise producing equipment, such as ballasts, magnetic starters, etc.
 - 7. All analog inputs and analog outputs shall be wired using shielded cable.
 - 8. All digital outputs shall be wired using 18 gauge stranded wire.
 - 9. All wiring in mechanical rooms, walls shall be installed in EMT conduit. Concealed conduit and wiring is required in all finished spaces.
- C. DDC Equipment:
 - 1. All components shall be installed in protective enclosures. Wiring within the DDC enclosure shall be either number coded or color coded. Both the enclosure and the controller shall be

- properly grounded in accordance with manufacturer's recommendation. Documentation shall be firmly attached to the enclosure within a plastic envelope. Documentation shall state point-to-point termination detail, description of each individual point, location of power source for the controller, and ID number or address within the network.
2. All DDC Controllers shall be mounted on walls within equipment rooms, custodial closets, or electrical rooms. Only application-selectable controllers (ASCs) for VAV boxes, heat pumps, unit ventilators, rooftop units, or package units may be mounted on the equipment.
- D. Color Graphic Software:
1. Provide graphic screens depicting the actual layout for all major equipment, as required.
 2. Provide graphic representation of the building, including building floor plans. Provide common information and status within these screens, such as zone temperature, equipment status, etc.
 3. Coordinate with the Owner prior to loading and testing.
- E. Sensing Device Installation:
1. Freezestats: Provide where indicated in the sequences on discharge side of the first coil, downstream of the filter section. Serpentine the element across the face of the coil and fasten using support rods.
 2. Space Sensors/Transmitters: Provide as required by the sequences and shown on the Drawings. Mount at 60 inches above finished floor. Wire to respective PUC or ASC to provide stand-alone control.
 3. Duct Mounted Sensors/Transmitters: Provide as required by the sequences. Averaging type sensors shall be supplied for all mixed air and discharge air locations. Serpentine across the duct opening at even increments and provide proper fastening.
 4. Liquid Immersion Sensor/Transmitter: Provide as required by the sequences. Coordinate the installation of all wells and sensor using thermal conductive compound. Strap on sensors are not acceptable, except for aqua stats.
- F. Controlled Devices:
1. Dampers: Dampers shall be installed as specified in Section 23 30 00 - HVAC Air Distribution, coordinate the installation of linkage assembly. Dampers shall operate smoothly throughout their entire stroke.
 2. Valves: Valves shall be installed as specified in Section 22 14 13 - Facility Storm Drainage Piping. Coordinate locations so that valves are piped properly and installed in an acceptable location. Valves shall provide proper shut-off as specified in this section.
 3. Actuators: All actuators shall be provided as specified in Section 23 09 13 - Instrumentation and Control Devices for HVAC. Provide supply air as required. Where freezing conditions may occur, provide localized desiccant drying.
 4. Pipe Access: Coordinate all thread-olets specified in Section 22 14 13 - Facility Storm Drainage Piping.

4.03 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow adequate time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Furnish service technician employed by system installer to instruct Owner's representative in operation of systems plant and equipment for a 3 day period.

4.04 SYSTEM STARTUP AND COMMISSIONING

- A. System Startup and Commissioning:
 1. Demonstrate that all points connected to the system operate fully in accordance with this specification.
 2. Upon completion of installation, initially start-up and test all equipment being controlled using a portable operator interface connected to individual controllers.
 - a. Verify that all inputs are properly being read.
 - b. Measure, calibrate, and adjust all analog inputs, including temperature sensors.
 - c. Stroke all analog outputs from 0 to 100 percent and verify all linkage adjustments are accurate.

- d. Verify valves and dampers fully close and provide tight shut-off with no leakage.
- e. Verify all digital outputs are properly energizing the controlled device.
- f. Adjust setpoints so equipment can run properly.
- 3. Verify from host computer that all of the controllers are being addressed from the host. Verify communication speed is acceptable and meets the requirements of this specification.
- 4. Coordinate work with air-balancing, ventilation, piping, and electrical work to provide complete system commissioning.
- 5. Provide a Commissioning Report detailing the dates, times, and person(s) performing the start-up. Include detail of when and who performed the individual processes specified above.

4.05 DEMONSTRATION AND TRAINING

- A. Furnish basic operator training for 4 persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 16 hours instructor time. Furnish training on site.
- B. Demonstrate complete and operating system to Owner.
- C. Training
 - 1. Initial training shall occur during system start-up and commissioning.
 - 2. Immediately after commissioning is complete as specified, the controls system manufacturer shall provide a four hour, on-site session detailing the layout of the control system including network wiring routes, control panel locations, transformer locations, etc.
 - 3. After completion of the on-site session the Operation and Maintenance manual shall be reviewed with the Owner and shall include but not be limited to:
 - a. Fundamental operation of the system.
 - b. Training on setpoint adjustment and scheduling modifications
 - c. Operation and sequencing of control loops for all mechanical equipment being controlled
 - 4. Provide telephone support and answer questions throughout the warranty period.

4.06 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 23 09 00

**SECTION 23 09 13.23
BAS SENSORS AND TRANSMITTERS**

PART 1 GENERAL

1.01 REFERENCES

- A. Refer to Section 23 09 00 - References

1.02 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

- A. Refer to Section 23 09 00 - Acronyms, Abbreviations and Definitions

PART 2 PRODUCT

2.01 SENSORS AND DEVICES

- A. Input/output sensors and devices shall be closely matched to the requirements of the BAS controller for accurate, responsive, noise-free signal input/output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control.
- B. Sensors and transmitters shall be manually calibrated on site so that the wiring length does not detract from the sensor accuracy specified.
- C. Provide guards (plastic or wire) for sensors, thermostats, and transmitters that are installed in public areas such as gymnasiums, classrooms, corridors, and vestibules.
- D. RTD Transmitter
1. Where reference is made on the drawings for a RTD transmitter, it shall be interpreted as follows:
 2. Transmitters shall meet at minimum the following requirements:
 - a. Provide an RTD transmitter in configurations below meeting the following requirements:
 - 1) 100 ohm or 1000 ohm PT RTD
 - 2) 24V ac/dc power supply.
 - 3) 4-20 mA, 0-10Vdc or 0-5Vdc outputs compatible with BMS.
 - 4) Electronics accuracy of +/-0.1% of span.
 - 5) Operating temperature range of 32°F to 158°F. OSA only - operating temperature range of -40°F to 185°F.
 - 6) Optional LCD display
- E. Temperature Sensor – Immersion - Thermo well Mounted
1. Provide thermo well mounted temperature sensors as indicated within the Field termination schedules and/or control diagrams as follows.
 2. Temperature sensors shall meet, at minimum, the following requirements:
 - a. Rigid 0.25" stainless steel probe of length, which is, at minimum, 20% of the pipe width.
 - b. Thermistor or RTD Compatible with BMS sealed in probe with three-part moisture protection system.
 - c. BMS shall report the monitored temperature with an accuracy of 0.5°C (1.0°F).
 - d. ABS housing with conduit entrance. (Optional metal or weather proof available)
 - e. Provide Brass or Stainless steel thermo well (316 or 304).
 - f. Provide with thermal grease to aid temperature sensing.
- F. Combination Relative Humidity And Temperature Sensors
1. Where there is a requirement for the monitoring of both relative humidity and temperature at the same location, the BMS Contractor shall provide a combination relative humidity sensor and temperature sensor. The individual sensors must each meet the specifications details above.
- G. Water Pressure Sensor
1. Provide water pressure sensors as indicated within the Field termination schedules and/or control diagrams. Pressure sensors shall meet the following requirements:
 - a. Operating range shall be suitable for the application. Select range such that it covers from zero pressure to twice the amount of pressure desired for control purposes or that could be encountered.

- b. 4-20 mA output proportional to water pressure.
 - c. 0.25% accuracy of range.
 - d. Temperature range of -40°F to 260°F.
 - e. Over pressure input protection of a minimum two times rated input.
 - f. An optional ABS wiring housing is available for an interior application and weatherproof wiring housing is available for an exterior application.
 - g. 17-4PH stainless steel wetted parts.
 - h. Burst pressure of a minimum five times rated input.
- H. Water Flow Meter
- 1. Inline style dual turbine insertion flow meter:
 - a. +/- 0.5% of reading at calibrated velocity
 - b. +/- 1% of reading from 3 to 30 ft/s
 - c. Sensing method: Electronic impedance sensing (non-magnetic and non-photoelectric)
 - d. Pipe size range: 2" through 72" diameter
 - e. Temperature rating: 280°F continuous, 300°F peak (hot water), 150°F continuous, 200°F peak (chilled water)
 - f. Operating pressure: 400 psi maximum
 - g. Wetted material: 316 stainless steel
 - h. Controls Contractor to coordinate output signal
 - i. NEMA 4 enclosure with 10' of cable and 1/2" NPT conduit connection
 - 2. Manufacturers:
 - a. Onicon F-1000 series
- I. Water Differential/Gage Pressure Sensor
- 1. Provide water differential or gage pressure sensors as indicated in the Field termination schedules and /or control diagrams. Water differential pressure sensors shall meet, at minimum, the following requirements:
 - a. Output of 4-20 mA, 0-10 or 0-5 Vdc proportional to the pressure sensed.
 - b. Momentary over pressure protection of five times the rated input.
 - c. Operating range shall be suitable for the application. Select range such that it covers from zero differential pressure up to a differential static pressure of 20% to 50% in excess of the maximum static pressure that could be encountered. Remember that if the sensor is used for the control of a chilled water bypass and is located across, for example, a chilled water AHU coil, the pressure drop of both the coil and the associated valve at full design flow have to be taken into account.
 - d. Accuracy of better than 1% of full-scale reading.
 - e. Valve tapping shall be furnished and installed by the Mechanical contractor. Coordinate with the Mechanical contractor.
- J. Current Relay/Switch
- 1. Provide current sensing relays as indicated in the Field termination schedules and/or control diagrams. Current sensing relays shall meet, at minimum, the following specifications:
 - a. Rated for the applicable load.
 - b. The output relay shall have an accessible trip adjustment over its complete operating range. Provide LED indication of relay status.
 - c. Current relay shall have input and output isolation via current transformer.
 - d. Current relay shall be self-powered with no insertion loss.
 - e. Relay shall be in a dustproof housing.
 - f. Accuracy to be <2% of full-scale max.
 - g. Temperature rating of 5°F to 140°F.
 - h. Whenever the status of a single speed motor is monitored it shall be done via a current sensing relay.
 - i. The BMS contractor shall provide current sensing relays at the MCC starters.
 - j. The BMS contractor shall provide the current sensing relays for motors with local starters and no MCC starter.

K. Current Sensor

1. Provide monitoring of the current as identified in Field termination sheets and/or control drawings. Current monitoring shall meet, at minimum, the following requirements:
 - a. 4-20 mA, 0-10 or 0-5 Vdc output proportional to current draw.
 - b. Reverse polarity protected and output limited.
 - c. 50/60 Hz operation.
 - d. Accuracy of better than 1%.
 - e. Operating temperature range of -20°F to 120°F.

PART 3 EXECUTION

3.01 INSTALLATION OF SENSORS

- A. Install sensors according to manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for operating environment.
- C. Install room temperature sensors on concealed junction boxes properly supported by wall framing. Box heights shall be coordinated with Division 26 and other trades such that device heights match exactly light switches and other similar control devices.
- D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
- E. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- F. Install outdoor air temperature sensors on north wall at designated location with sun shield.
- G. Smoke detectors, high and low limit thermostats, 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.

3.02 FLOW SWITCH INSTALLATION

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch according to manufacturer's instructions.

END OF SECTION 23 09 13.23

**SECTION 23 09 33
VARIABLE FREQUENCY DRIVE**

PART 1 GENERAL

1.01 DESCRIPTION

- A. This specification covers variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD panel.
- B. The VFD shall be NEMA Type 1 or NEMA Type 12 as required on the schedule.
- C. The VFD shall have been evaluated by UL and found acceptable for mounting in a plenum or other air handling compartment.
 - 1. Manufacturer shall supply a copy of the UL plenum evaluation upon request.
- D. The VFD shall be tested to UL UL 61800-5-1
 - 1. The appropriate UL label shall be factory applied.
- E. VFD shall be manufactured in ISO 9001, 2000 certified facilities.
- F. The VFD shall be CE marked and conform to the European Union ElectroMagnetic Compatibility directive.
- G. The VFD shall be UL listed for a short circuit current rating of 65 kAIC and labeled with this rating.
- H. To ensure adequate technical and factory support, VFDs manufactured by others and brand labeled shall not be acceptable.
- I. The VFD manufacturer shall supply the VFD and all necessary controls as herein specified.
- J. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB
- B. Danfoss
- C. Eaton
- D. Honeywell
- E. Schneider
- F. Siemens
- G. Yasakawa
- H. Or Approved Equal

2.02 DESCRIPTION

- A. The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors.
- B. The motor current shall closely approximate a sine wave.
- C. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.
- D. When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor.
- E. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
- F. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

- G. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating.
 - 1. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.
- H. VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
- I. The VFD's full load output current rating shall meet or exceed NEC Table 430-150.
- J. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 135% of rated torque for up to 0.5 second while starting.
- K. The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed.
 - 1. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds.
- L. A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
- M. The VFD must be able to produce full torque at low speed to operate direct drive fans.
- N. The VFD must be capable of connection and disconnection to motor while the VFD is under load.
 - 1. This switching shall be accomplished without interlocks or damage to the VFD.
- O. An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency.
 - 1. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.
- P. Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents.
 - 1. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.
- Q. VFD shall minimize audible motor noise through the use of an adjustable carrier frequency.
 - 1. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise.
 - 2. VFDs with fixed carrier frequency are not acceptable.
- R. All VFDs shall contain integral EMI filters to attenuate radio frequency interference conducted to the AC power line.

2.03 PROTECTIVE FEATURES

- A. A minimum of Class 20 I2t electronic motor overload protection for single motor applications shall be provided.
 - 1. Overload protection shall automatically compensate for changes in motor speed.
- B. The Contractor shall provide an auxiliary input from any downstream disconnecting means, to the permissive interlock of the VFD, to stop the VFD if the downstream disconnecting means is opened while the load is being powered. Coordinate with division 26 to ensure downstream disconnecting means is provided with auxiliary contacts.
- C. Protection against input transients, loss of AC line or load phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature.
 - 1. The VFD shall display all faults in plain language. Codes are not acceptable.
- D. Protect VFD from input phase loss.
 - 1. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition,

2. The VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed.
 3. This function is independent of which input power phase is lost.
- E. Protect from under voltage.
1. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal.
 2. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.
- F. Protect from over voltage.
1. The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.
- G. The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.
- H. VFD shall include a "signal loss detection" algorithm with adjustable time delay to sense the loss of an analog input signal.
1. It shall also include a programmable time delay to eliminate nuisance signal loss indications.
 2. The functions after detection shall be programmable.
- I. VFD shall function normally when the keypad is removed while the VFD is running.
1. No warnings or alarms shall be issued as a result of removing the keypad.
- J. VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.
- K. Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.
- L. VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload.
1. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.
- M. If the temperature of the VFD's heat sink rises to a critical level, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature.
1. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.
- N. In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.
- O. The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life.
1. The drive fan speed can be preprogrammed at preset speeds or run in Auto mode.
 2. At low loads or low ambient temperatures, the VFD may even turn the fan(s) off even when the VFD is running.
- P. The VFD shall store in memory the last 10 alarms.
1. A description of the alarm, and the date and time of the alarm shall be recorded.
 2. The VFD shall include graphing capability for the last 2 alarms to provide additional diagnostic analysis.
- Q. When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve.
1. It shall be programmable to take appropriate protective action when one of the above situations is detected.

2.04 INTERFACE FEATURES

- A. Hand, Off and Auto keys shall be provided to start and stop the VFD and determine the source of the speed reference.

1. It shall be possible to either disable these keys or password protect them from undesired operation.
- B. There shall be an "Info" key on the keypad.
 1. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.
- C. The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode.
 1. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.
- D. Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted.
 1. Two levels of password protection shall be provided to guard against unauthorized parameter changes.
- E. All VFDs shall have the same customer interface.
 1. The keypad and display shall be identical and interchangeable for all sizes of VFDs.
- F. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD.
 1. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.
 2. Keypad shall provide visual indication of copy status.
- G. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided.
 1. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
- H. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD.
 1. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.
- I. A three-feedback PID controller to control the speed of the VFD shall be standard.
- J. This controller shall accept up to three feedback signals.
 1. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or the feedback signal as the controlling signal.
 2. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
- K. The VFD shall be able to apply individual scaling to each feedback signal.
- L. For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.
- M. The VFD's PID controller shall be able to actively adjust its setpoint based on flow.
 1. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.
- N. The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.
- O. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
- P. Five simultaneous meter displays shall be available.
 1. They shall include at a minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.
- Q. Programmable Sleep Mode shall be able to stop the VFD.
 1. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop.

2. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start.
3. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.
- R. A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation.
 1. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.
- S. VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F).
- T. VFD shall be programmable to sense the loss of load.
 1. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.
 2. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

2.05 STANDARD CONTROL AND MONITORING INPUTS AND OUTPUTS

- A. Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- B. Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
- C. Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.
- D. Each relay shall have an adjustable on delay / off delay time.
- E. Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.
- F. Each shall be independently selectable to be used with either an analog voltage or current signal.
- G. The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
- H. A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
- I. The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,
- J. One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status.
 1. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power.
 2. It shall be possible to scale the minimum and maximum values of this output.
- K. It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.
- L. It shall be possible to command all digital and analog output through the serial communication bus.

2.06 OPTIONAL CONTROL AND MONITORING INPUTS AND OUTPUTS

- A. It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.
- B. These modules shall use rigid connectors to plug into the VFD's control card.
- C. The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
- D. Modules may include such items as:
 1. Additional digital outputs, including relay outputs
 2. Additional digital inputs

3. Additional analog outputs
4. Additional analog inputs, including Ni or Pt temperature sensor inputs
- E. It shall be possible through serial bus communications to control the status of all analog and digital outputs of the VFD.
 1. Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands.
 2. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload.
 3. The VFD shall display FIREMODE whenever in firefighter's override mode.
 4. Fire-mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.
- F. A real-time clock shall be an integral part of the VFD.
 1. It shall be possible to use this to display the current date and time on the VFD's display.
 2. Ten programmable time periods, with individually selectable ON and OFF functions shall be available.
 3. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. It shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates.
 4. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.
- G. All VFD faults shall be time stamped to aid troubleshooting.
- H. It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.
- I. The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.
- J. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.
- K. The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
 1. Comparators for comparing VFD analog values to programmed trigger values
 2. Logic operators to combine up to three logic expressions using Boolean algebra
 3. Delay timers
 4. A 20-step programmable structure
 5. The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of additional constant speed motor starters.

2.07 SERIAL COMMUNICATIONS

- A. The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
 1. BACnet IP
 2. Option board only
- B. Option boards for the following protocols shall be available:
 1. BACnet Expanded
 2. Ethernet
 3. LonWorks Free Topology (FTP) certified to LonMark standard 3.3
- C. VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD.
 1. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port.
 2. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

- D. The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

2.08 ADJUSTMENTS

- A. The VFD shall have a manually adjustable carrier frequency to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.
- B. Four independent setups shall be provided.
- C. Four preset speeds per setup shall be provided for a total of 16.
- D. Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.
- E. Each setup shall be programmable for a unique current limit value.
 - 1. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD.
 - 2. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.
- F. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.
- G. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
- H. An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.
- I. Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

2.09 OPTIONAL FEATURES

- A. All optional features shall be built, mounted and tested by the VFD manufacturer.
 - 1. The VFD manufacturer's warranty shall apply to the entire assembly as shipped.
 - 2. Packages built by third parties and do not carry the VFD manufacturer's warranty shall not be allowed.
 - 3. All options shall carry a UL / C-UL Enclosed Industrial Control Panel label.
 - 4. All panels shall be marked for 100,000 amp short circuit current rating.
- B. The enclosure rating of the VFD w/ options shall be consistent with the VFD rating of either NEMA/UL type 1 or NEMA/UL type 12, as required for the installation location and/or as called for on the schedule.
 - 1. The package shall include ALL optional devices and shipped as a complete factory tested assembly.
- C. Three Contactor bypass shall be provided that allows operation of the motor via line power in the event of a failure of the VFD.
 - 1. Motor control selection shall be through either a VFD output contactor or a bypass contactor that is electrically interlocked to ensure that both contactors are not energized simultaneously.
 - 2. A third contactor, the drive input contactor, shall be supplied as standard.
 - 3. This allows the powering of the VFD with the motor off or operating in bypass mode for testing, programming and troubleshooting purposes.
- D. The Three Contactor bypass shall include the following interface and control features:
 - 1. Mode selection via a four position DRIVE/OFF/BYPASS/TEST switch.

2. DRIVE Mode: Both the drive input and output contactors are closed and the motor is operated via VFD power
 3. OFF mode: DRIVE input, drive output and bypass contactors are all open.
 4. Bypass mode: Bypass contactor is closed and motor is operating from line power. Both the drive input and drive output contactors are open for servicing of the VFD without power.
 5. Test mode: Bypass contactor is closed and the motor is operated from line power. The drive input contactor is closed but the drive output contactor is open. This allows for the testing and programming of the VFD while the motor is operated via line power.
- E. Contactors shall operate from a 24vdc power supply that shall function off of any two legs of the AC line and shall maintain power on the loss of any one of the AC lines.
- F. A Bypass pilot light is supplied to indicate that the motor is operating from line power.
- G. Common start/stop command when operating in either Bypass or VFD mode.
- H. Selectable Run Permissive logic shall operate in either VFD or bypass operation.
1. When activated, any command to start the motor, in either Hand Bypass, Remote Bypass, Hand VFD or Remote VFD shall not start the motor, but instead close a relay contact that is used to initiate operation of another device, such as an outside air damper.
 2. A contact closure from this device shall confirm that it is appropriately actuated and the motor shall then start.
- I. Bypass package shall include an External Safety interlock that will disable motor operation in either bypass or VFD when open.
- J. Fire-mode bypass operation shall be standard.
1. When activated via a contact closure, the motor shall transfer to bypass (line power) regardless of the mode selected.
 2. All calls to stop the motor shall be ignored.
 3. These include the opening of the start command, an external safety trip or the tripping of the motor overload.
 4. Fire-mode operation will take precedence over all other commands.
- K. The bypass must include a selectable time delay of 0 to 60 seconds before the initiation of bypass operation.
1. When transferring from VFD to bypass modes, the time delay starts after the motor has decelerated to zero speed.
 2. This delay allows the BAS to prepare for bypass operation.
 3. Bypass packages that do not include a time delay, or do not include a selectable delay period, will not be acceptable.
- L. Automatic bypass shall be selectable.
1. When active, the motor shall be transferred to line power on a VFD fault condition.
 2. The bypass time delay shall be activate prior to this transfer to line power to allow the VFD time to attempt to recover from the fault condition prior to running in bypass.

2.10 PROTECTIVE FEATURES

- A. Main input disconnect shall be provided that removes power from both the bypass and VFD.
- B. Main input motor rated fuses that protect the entire package.
- C. VFD only fast acting input fuses shall be provided. Packages that include only main input motor rated fusing or circuit breaker are not acceptable.
- D. Overload protection shall be supplied in bypass mode.
- E. This overload shall supply minimum class 20 protection as well as wide adjustable current setting for complete motor protection when operating on line power.
 1. Those overloads that are not class 20 or current selectable will not be acceptable.
- F. Overload protection shall include phase loss and phase imbalance protection.
- G. For 460V/600V units 75 Hp and below and 208V/230V units 40 Hp and below, low voltage contactor operation shall be maintained down to 70% of the unit's nominally rated voltage, to

ensure VFD operation.

- H. For 460V/600V units 75 Hp and below and 208V/230V units 40 Hp and below, the VFD shall be able to operate the motor at a reduced load with the loss of any one of the three phases of power.
 - 1. Contactors shall remain closed regardless of which phase is lost to ensure VFD operation.

2.11 LINE/LOAD CONDITIONERS

- A. VFDs that do not include 5% DC link impedance shall include 5% AC line reactors in the options enclosure. Lower levels of impedance will not be acceptable.

2.12 SERVICE CONDITIONS

- A. Ambient temperature, continuous, full speed, full load operation:
 - 1. 14 to 113°F on Non-Bypass units
 - 2. 14 to 104°F on Bypass units
 - 3. 5 to 95% relative humidity, non-condensing.
 - 4. Elevation to 3,300 feet without derating.
 - 5. AC line voltage variation, -10 to +10% of nominal with full output.
 - 6. All power and control wiring shall be from the bottom.
 - 7. All VFDs shall be plenum rated.

2.13 QUALITY ASSURANCE

- A. To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.
- B. All optional features shall be functionally tested at the factory for proper operation.

PART 3 EXECUTION

3.01 START-UP SERVICE

- A. The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services.
- B. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents.
- C. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.
- D. Harmonic filtering.
 - 1. The VFD supplier shall, with the aid of the buyer's detailed electrical power single line diagram showing all impedances in the power path to the VFDs, perform an analysis to initially demonstrate the supplied equipment will meet the IEEE recommendations after installation.
 - 2. If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the drive supplier quotation.

3.02 WIRING

- A. All wiring from the load size of VFDs to the motor terminals shall be VFD cable.
- B. Cable shall have the following characteristics:
 - 1. UL listed to 1277 and 2277
 - 2. Type RHH/RHW-2 insulation, 90 deg C
 - 3. Three phase conductors and one green ground with yellow stripe cross linked insulation. Size equal to phase conductor.
 - 4. 600 Volt
 - 5. Shielding: 100% coverage Alum/Mylar/Alum Foil, overall 85% coverage tinned copper braid
 - 6. Jacket: Black thermoplastic elastomer TPE
- C. Manufacturers:
 - 1. Southwire

2. General Cable
3. Belden

3.03 WARRANTY

- A. The complete VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment.
 1. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service.
 2. The warranty shall be provided by the VFD manufacturer and not a third party.
 3. A written warranty statement shall be provided with the submittals.

END OF SECTION 23 09 33

SECTION 23 21 13 HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Chilled water piping, buried.
- C. Chilled water piping, above grade.
- D. Equipment drains and overflows.
- E. Pipe hangers and supports.
- F. Unions, flanges, mechanical couplings, and dielectric connections.

1.02 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
- E. ASME B31.9 - Building Services Piping 2020.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023.
- H. ASTM B32 - Standard Specification for Solder Metal 2020.
- I. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.
- J. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
- K. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers 1992 (Reapproved 2022).
- L. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications 2007 (Reapproved 2019).
- M. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.
- N. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).
- O. AWWA C606 - Grooved and Shouldered Joints 2022.
- P. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

1.03 SUBMITTALS

- A. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- B. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Indicate valve data and ratings.
 - 3. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Submit Flushing and Cleaning Plan:
 - 1. All new hydronic piping shall be flushed and cleaned

2. Submit pipe flushing/cleaning plan for piping systems (chilled water, heating hot water, etc.) for approval. The plan shall include detailed methods for compliance with requirements of this section, including:
 - a. Flushing and cleaning procedure narratives.
 - b. Size, power source, and connection points of contractor provided pumps that will be used for flushing and cleaning. Use of new or existing building pumps for flushing/cleaning systems will NOT be permitted.
 - c. At all new coils, provide temporary flushing bypass lines.
 - d. For existing coils on other areas of the floor, contractor shall provide a means to bypass coils to ensure system can be flushed clean. This may involved isolating individual coils for initial flush of mains, followed by individual flush at strainer blowdowns for secondary flush.
 - e. Remove critical components (control valves, water meters, etc.) that could be damaged and provide temporary spool pieces in piping and provide temporary bypass around coils which could be damaged by circulating debris.
 - f. Flushing schedule and drawings or diagrams to be used shall be signed off by Engineer, CxA, and Owner.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section with minimum five years of experience.
- C. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.06 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 2. Use only long radius elbows having centerline radii of 1.5 pipe diameters unless otherwise indicated.
 3. Where size for a pipe segment is not indicated, the pipe segment shall be equal to the largest pipe segment to which it is connected. Transition to smaller size shall occur on the side of the fitting where smaller size is indicated.
 4. Unless otherwise indicated, fittings and accessories connected to pipe shall be of the same material as the pipe.
 5. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - a. On 2" piping and smaller, it is permissible to use ball valves in lieu of dielectric unions.

- C. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- D. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
 - 1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.
- E. Valves: Provide valves where indicated:
 - 1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
 - 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 - 3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

2.02 CHILLED WATER PIPING, BURIED

- A. Pre-insulated Steel Piping System. All pre-insulated pipe, fittings, insulating materials, and technical support shall be provided by the Pre-insulated Piping System manufacturer.
- B. Carrier Piping: Steel ASTM A-53, Grade B., ERW (Type E) or seamless (Type S), standard weight for sizes 2" and larger, and shall be ASTM A-106/ A-53, seamless, standard weight for sizes 1-1/2" and smaller (Std. Wt. is the same as Sch. 40 through 10"). When practical, piping shall be provided in 40-foot double-random lengths. All carbon steel pipe shall have ends cut square and beveled for butt-welding. Straight sections of factory insulated pipe shall have 6" of exposed pipe at each end for field joint fabrication and welding.
- C. Insulation: Insulation shall be polyurethane foam either spray applied or injected with one shot into the annular space between carrier pipe and jacket. Insulation shall be rigid, 90% minimum closed cell polyurethane with a minimum 2.0 lbs per cubic foot density, compressive strength of 30 psi, and coefficient of thermal conductivity (K-Factor) of not higher than 0.18 @ 75°F per ASTM C-518. Maximum operating temperature shall not exceed 250°F. Insulation thickness shall be minimum 2".
- D. Jacketing material shall be extruded, black, high density polyethylene (HDPE), having a wall thickness not less than 100 mils for jacket sizes less than or equal to 12", 125 mils for jacket sizes larger than 12" to 24", and 150 mils for jacket sizes greater than 24". No tape jacket allowed. The inner surface of the HDPE jacket shall be oxidized by means of corona treatment, flame treatment, or other approved methods. This will ensure a secure bond between the jacket and foam insulation preventing any ingress of water at the jacket/ foam interface.
- E. Straight run joints shall be field-insulated per the manufacturer's instructions, using polyurethane foam poured in an HDPE sleeve and sealed with heat shrink sleeve. All joint closures and insulation shall occur at straight sections of pipe. All insulation and jacketing materials shall be furnished by the piping system manufacturer.
- F. Fittings are shall be factory pre-fabricated and pre-insulated fittings with poly-urethane foam to the thickness specified and jacketed with a one-piece seamless molded HDPE fitting cover, a butt fusion welded, or an extrusion welded and mitered HDPE jacket. Carrier pipe fittings shall be butt-welded, except sizes smaller than 2" shall be socket-welded. (At the Engineer's option, fittings can be pre-fabricated/ pre-engineered.) Fittings include expansion loops, elbows, tees, reducers, and anchors. Elbows, loops, offsets, or any other direction changes shall conform to the standards set by ASME B31.1, Code for Power Piping.
- G. Expansion/ contraction compensation will be accomplished utilizing factory pre-fabricated and pre-insulated expansion elbows, Z-bends, expansion loops, and anchors specifically designed for the intended application. External expansion compensation utilizing flexible expansion pads (minimum one inch thickness), extending on either side, both inside and outside the radius of the fittings are used with all fittings having expansion in excess of 3/4".
- H. Underground systems shall be buried in a trench of not less than 24 inches deeper than the top of the pipe jacket and not less than 18" wider than the combined O.D. of all piping systems. Back-fill

should be tamped compactly in place. No rock shall be used in the first foot of back-fill. Twenty-four (24) inches from top of jacket to grade of compacted fill will meet H-20 highway loading.

- I. Manufacturers:
 - 1. Energy Task Force
 - 2. Insul-Tek
 - 3. Thermacor

2.03 CHILLED WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Type E for pipe getting welded, Schedule 40, black; using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - 2. Threaded Joints: ASME B16.3, malleable iron fittings. Only for 2 inch and under.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), hard drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 - 2. Copper tube may be used on 2" pipe size and under.

2.04 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - 2. Copper pipe shall be used for all condensate and other drains, except condensing boiler drains.

2.05 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. Cooper B-Line
 - 2. Anvil International
 - 3. PHD
- B. All hangers, supports, and hardware shall have hot-dip galvanized finish complying with ASTM A123 or ASTM A153. Epoxy plated or coated hardware will NOT be accepted.
- C. Comply with Federal Specification WW-H-171E & A-A-1192A.
- D. Hangers shall be UL Listed and FM Approved.
- E. Refer to the Structural Drawings and Details for the limitations and applications of each type of hanger and weight when attaching to bar joists, trusses, or other building Structural elements. The Contractor shall be responsible for providing additional miscellaneous steel, unistrut, and other components to span multiple joists as required by the Structural Drawings to distribute concentrated loads.
- F. Provide hangers and supports that comply with MSS SP-58 and MSS SP-69.
 - 1. Pipe Hangers for Hot and Chilled Water 6" and smaller: Cooper B3100, Anvil Fig. 260, or equivalent.
 - 2. Hangers for Hot Pipe 8" and larger: Adjustable steel yoke, cast iron roll, double hanger. Cooper B3110, Anvil Fig. 181, or equivalent.
 - 3. Riser Clamps: Cooper B3373, Anvil Fig. 40, or equivalent.
 - 4. Beam Clamps: Cooper B3050, Anvil Fig. 134, or equivalent.
 - 5. Offset Clamps: Cooper B3148, Anvil Fig. 103, or equivalent.
 - 6. Ceiling Plate: Cooper B3199, Anvil Fig. 610, or equivalent.
 - 7. Wall Brackets: Cooper B3067, Anvil Fig. 199, or equivalent.
 - 8. Rod Ceiling Plate: Cooper, Anvil Fig. 610, or equivalent.
 - 9. Concrete Inserts: Cooper B2500, Anvil Fig. 95 or equivalent.

10. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 11. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded. Cooper B3205, Anvil Fig. 146, or equivalent.
- G. All hangers, rods, and other hardware shall be hot-dip galvanized, except where copper plated for copper piping.
- H. Pipe Saddles:
1. Manufacturers
 - a. Buckaroos
 - b. GLT Products
 - c. PHD
 2. Length
 - a. 12" for piping up to 4"
 - b. 18" for 6"
 - c. 24" for piping up to 14"
 3. Comply with MSS SP-58
 4. Galvanized G-90 finish

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment using jointing system specified.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. See Section 23 25 00 for additional requirements.

3.02 PRESSURE TESTS

- A. Piping pressure tests shall be required on all new piping.
 1. Where connecting to existing systems, segregate new piping from existing system and provide isolation valves as required for testing.
- B. Coordinate pressure tests with the Engineer and Owner at least 72 hours in advance. Engineer, Owner, and CxA may choose to witness the pressure test. If Owner and Engineer decide not to witness a specific test, the Construction Manager/General Contractor shall witness the test and sign off.
- C. Conduct pressure tests prior to flushing and cleaning of piping systems.
- D. Pressure tests may be made of isolated portions of the piping systems to facilitate general progress of the installation. Changes made in the piping system shall require retesting of the affected portions.
- E. No system or part of the system shall be insulated until it has been successfully tested. If required for additional pressure load under test, provide temporary restraints at expansion joints or isolated them during test.
- F. All hydronic piping shall be hydrostatically tested to 150 psi for a period of four (4) hours minimum.
 1. Use ambient temperature water as a testing medium unless there is a risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used if approved by the Engineer.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Subject piping system to hydrostatic test pressure. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 4. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

5. No pressure drop shall occur during test period.
6. Prepare written report of testing.
- G. Provide pumps, appropriately scaled gauges, calibrated instruments and test equipment, temporary piping, and personnel for tests. Remove all test equipment and drain pipes after completion of testing.
- H. If piping system is drained after testing and left empty or untreated for more than 3 days, add Nalco 2572 or equivalent at recommended dosages for dry system lay-up.

3.03 FLUSHING AND CLEANING OF PIPING SYSTEMS

- A. Notify Engineer and Owner/CxA at least four (4) days in advance. Do not flush any piping system or portion thereof without prior submission and approval of flushing and cleaning plan.
- B. General:
 1. All hydronic piping systems shall be tested and flushed. All temporary equipment, utilities, and materials, including water, required to perform the tests and flushing shall be the responsibility of the contractor. Tests and flushes shall be witnessed by the Engineer or Owner's representative. The contractor shall perform pre-testing so that the Engineer may witness the final test and flush only. If more than one test and flush are required, contractor shall schedule these with the Engineer's site observation schedule. Submit contractor's testing and flushing plan, indicating how the system will be divided for flushing, chemical injection points, temporary bypass piping, temporary drains, etc.
 2. Test fluid shall be clean water
 3. Flush fluid shall be clean water with listed cleaning chemicals
 4. Fill fluid shall be clean water
- C. Flushing and Fill:
 1. Flush entire piping system until clean. Flush velocity shall be minimum of 5 fps through all sections of the system.
 2. Contractor shall provide portable pumping apparatus. Provide temporary materials, valves, equipment, and infrastructure, required to create bypass(es) for a closed system to perform flush(es). Bypass permanent building pumps during flush. Remove any devices that could be clogged or damaged prior to flushing. Provide a grade 18-8 stainless steel screen with 3/16 inch diameter holes at 18 holes per square inch in system strainers. Install #100 mesh startup liner in system strainer with metal screen. Operate valves as necessary to ensure all sections of the system are flushed for the required time period.
 3. Provide temporary piping to bypass coils, control valves, and other factory cleaned equipment, as wells as equipment subject to damage.
 4. Dissolve the following chemicals in the system (listed in pounds per 1,000 gallons of system water):
 - a. EDTA 40 lbs
 - b. CITRIC ACID 35 LBS
 - c. SURFACTANT 4 ounces product: Tritan DF-16 or equivalent low-foaming surfactant
 5. After initial 12 hours of flushing, screens and strainers shall be pulled, checked, and cleaned. Flushing shall then continue for another 12 hours. At the end of 24 hours, if strainers are still showing debris, continue flushing for 6 additional hours. System shall be flushed for a minimum of 24 hours and up to 30 hours as required.
 6. After completion of cleaning solution flushing, the system shall be completely drained to sanitary sewer. Flush with clean water. If the system cannot be drained completely, put a bleed on system and add clean water until system test at a pH of 6.8 to 7.4.
 7. Remove all temporary materials and bypass piping.
 8. Apply corrosion control chemicals with 2-3 days of flushing and cleaning procedure. Submit reports confirming concentration.
 9. Retesting and flushing
 - a. Any changes made to the piping systems after testing and/or flushing shall require retesting and flushing of the affected portions of the system. If any portion of the piping system is exposed to dirt or debris after the flush, it shall be re-flushed.
 10. Contractor Certification

- a. Provide a letter to the Engineer and Owner certifying the tests and flushes were performed in accordance with the specifications, what the final results were, and what the intermediate results were. The contractor's representative shall sign and date. A copy shall be placed in the O&Ms.
11. The Engineer or Owner/CxA shall review the test and flush results prior to opening a new portion of piping to a previously approved portion or an existing system. If the supporting documentation is not reviewed by the Engineer prior to opening, the entire system shall be flushed again.

3.04 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and to avoid interference with use of space.
- D. Group piping whenever practical at common elevations.
- E. Sleeve pipe passing through partitions, walls, and floors.
- F. Unless otherwise indicated, horizontal piping may be installed level or with a pitch up at 1" per 40' in direction of flow. Install manual air vents at all high points where air may collect. If vent is not in accessible location, extend air vent to nearest code acceptable drain location with vent valve located at nearest accessible location to pipe. Terminate vent valve within two feet above ceiling in accessible location.
- G. Main branches and runouts to terminal equipment shall be made at top (first choice) or top 45 degree (second choice), with drain valves suitably located for complete system drainage and manual air vents located as per above.
- H. Bottom connections to piping are not allowed under any circumstances, unless specifically approved by the Engineer on a case by case basis. If permitted by the Engineer, a line size Y-strainer with shutoff valve and blowdown valve shall be installed at branch connection.
- I. Mitered elbows, welded branch connections, notched tees, and "orange peel" reducers are not allowed. Unless specifically indicated, reducing flanges and reducing bushing are not allowed. Reducing bushings may be used for air vents and instrumentation connections.
- J. Contractor shall provide all manual air vents and drains (air vents at high points, drains at low points) in order to allow for appropriate air venting and to permit complete drainage of the entire system.
- K. Cut threads so that no more than 3 threads remain exposed after joint is made. Apply thread sealants to cleaned male ends. Assemble joint to appropriate depth and remove any excess pipe joint compound from tightened joint.
- L. Install valves, control valves, and piping specialties, including items furnished by others, as specified and/or detailed.
- M. Make connections to equipment installed by others where said equipment requires piping services indicated in this section.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- O. Slope piping and arrange to drain at low points.
- P. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- Q. Welded Joints:
 1. Use weld material diameter as procedurally required for type and thickness of work being done.
 2. Use sufficient argon pre-purge and argon post-purge for GTAW processes.
 3. Clean tacks before welding out. Remove slag after each pass by grinding to avoid slag inclusion.
 4. Weld reinforcement shall not exceed limits established in ASME B31.1

5. Brush each weld free of rust and paint with rust resistant product that matches surface color.
- R. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 2. Support horizontal piping as scheduled.
 3. Place hangers within 12 inches of each horizontal elbow.
 4. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 6. Provide copper plated hangers and supports for copper piping.
 7. Cut hanger rods to within 1" of nut.
- S. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 07 19.
- T. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00 .
- U. Install valves with stems upright or horizontal, not inverted.
- V. All trapeze hanger rods shall be cut to within 1" of the bottom nut.

END OF SECTION 23 21 13

SECTION 23 21 14 HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Strainers.
- E. Suction diffusers.
- F. Pump connectors.
- G. Combination pump discharge valves.
- H. Pressure-temperature test plugs.
- I. Balancing valves.
- J. Automatic flow control valves.
- K. Relief valves.
- L. Pressure reducing valves.

1.02 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2021.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.04 SUBMITTALS

- A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- B. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- C. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc
 - 2. Armstrong

3. ITT Bell & Gossett
 4. Nexus
 5. Taco, Inc
 6. Or Approved Equal
- B. Acceptance Volume Capacity: As indicated on drawings.
- C. Maximum Rated Working Pressure: 150 psi.
- D. Maximum Allowable Service Temperature: 240 degrees F.
- E. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 12 psi, and steel support stand.
- F. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
- G. Accessories: Provide air-charging fitting, bulls eye sight glass, pressure gauge, and tank drain ball valve.

2.02 AIR VENTS

- A. Manufacturers:
1. American Wheatley
 2. Armstrong International, Inc
 3. ITT Bell & Gossett
 4. Taco, Inc
 5. Or Approved Equal
- B. Manual Air Vent: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Air Vent:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- D. Provide where shown and wherever air traps might occur in the piping system. All down feed water risers shall have air vents. Provide access to all air vents.
- E. Maximum Fluid Pressure: 150 psi.
- F. Maximum Fluid Temperature: 250 degrees F.

2.03 AIR SEPARATORS

- A. Coalescing Air/Dirt Separators:
1. Manufacturers:
 - a. American Wheatley
 - b. Armstrong International, Inc
 - c. Caleffi
 - d. ITT Bell & Gossett
 - e. Nexus
 - f. Spirotherm, Inc
 - g. Taco
 - h. Or Approved Equal
 2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1 for maximum fluid service subject to application requirements and manufacturer's standard maximum operating conditions.
 3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
 4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to top of separator.

5. End Connections: Class 150 flanged for 2-1/2 inch and larger otherwise threaded.
6. Blowdown Connection: Threaded.
7. Size: Match system flow capacity.
8. Maximum Fluid Service Pressure: 150 psi.
9. Maximum Fluid Service Temperature: 250 degrees F.

2.04 STRAINERS

- A. Manufacturers:
 1. American Wheatley
 2. Armstrong International, Inc
 3. Flexicraft Industries
 4. Grinnell Products, a Tyco Business
 5. The Metraflex Company
 6. Victaulic Company of America
 7. Or Approved Equal
- B. Size 2 inch and Under:
 1. Provide threaded or sweat brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.
 2. Body Material by Fluid Service:
 - a. Cast Iron or Brass:
 - 1) Liquids: Up to 400 psi at 150 degrees F.
- C. Size 2-1/2 inch to 4 inch:
 1. Provide flanged iron body for 175 psi working pressure, Y pattern with 1/16 inch #304 stainless steel perforated screen.
 - a. Cast Iron:
 - 1) Liquids: Up to 200 psi at 150 degrees F.
- D. Size 5 inch and Larger:
 1. Provide flanged iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.
- E. Accessories: Provide air vent, hanging tag, outlet ball valve, and PT test plug extension.
- F. Each strainer shall be equipped with a short nipple and gate valve for blowdown.

2.05 SUCTION DIFFUSERS

- A. Manufacturers:
 1. Anvil International, Inc
 2. Armstrong
 3. Grinnell Products, a Tyco Business
 4. ITT Bell & Gossett
 5. Keckley Company
 6. Taco
 7. Victaulic Company of America
 8. Watts
 9. Or Approved Equal
- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.
- C. Performance: Suction diffusers shall be sized for a maximum 6 ft pressure drop at the design flow.
- D. Class 125:
 1. Horizontally or vertically mounted angle-pattern fitting with integral-cast vanes, fine particle mesh stainless steel screen and magnetic drain plugs for particle removal without disassembly.
 2. Maximum Operating Service: 175 psi and 300 degrees F.

3. Sizes, Material, and Connection:
 - a. 2 inch and Smaller: Cast iron body, threaded.
 - b. 2-1/2 to 12 inch: Ductile iron body, flanged.

E. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.06 PUMP CONNECTORS

- A. Manufacturers:
 1. Anvil International
 2. Ferguson Enterprises Inc
 3. The Metraflex Company
- B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 1. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion: 1.0 inch.
 - b. Lateral Movement: 0.5 inch.
 - c. Angular Rotation: 15 degrees.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
 2. End Connections: Same as specified for pipe jointing.
 3. Provide pump connector with integral vanes to reduce turbulent flow.
 4. Provide necessary accessories including, but not limited to, swivel joints.

2.07 COMBINATION PUMP DISCHARGE VALVES

- A. Manufacturers:
 1. Anvil International
 2. Crane Co.
 3. ITT Bell & Gossett
 4. Taco, Inc
 5. Victaulic Company of America
 6. Or Approved Equal
- B. Class 125:
 1. Maximum Service Operation: 175 psi at 125 degrees F.
- C. Triple-Duty Globe Type: Grooved cast-iron angle pattern body with bolt-on bonnet, position indicator, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, metering connectors, flow shutoff mechanism, and adjustable flow handle.
- D. Valves shall be sized with a maximum pressure drop of 5 feet at design flow rate and also allow a pressure drop of 25 feet when throttled.

2.08 PRESSURE-TEMPERATURE TEST PLUGS

- A. Manufacturers:
 1. Ferguson Enterprises Inc
 2. Peterson Equipment Company Inc
 3. Sisco Manufacturing Company Inc
 4. Or Approved Equal
- B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- C. Application: Use extended length plugs to clear insulated piping.

2.09 BALANCING VALVES

- A. Manufacturers:
 1. Armstrong International, Inc
 2. Caleffi
 3. Danfoss
 4. Griswold
 5. ITT Bell & Gossett

6. Jomar
 7. Nexus
 8. Nibco
 9. Taco, Inc
 10. Victaulic
 11. Or Approved Equal
- B. Size 2 inch and Smaller:
1. Provide globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and female sweat, NPT threaded, press, or soldered connections.
 2. Metal construction materials consist of bronze.
 3. Non-metal construction materials consist of Teflon or EPDM.
 4. Maximum Service Operation: 300 psi at 250 degrees F.
- C. Size 2-1/2 inch and Larger:
1. Provide globe or butterfly style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and flanged or weld-end connections.
 2. Valve body construction materials consist of cast iron or ductile iron.
 3. Internal components construction materials consist of bronze.
 4. Maximum Service Operation: 175 psi at 250 degrees F.

2.10 RELIEF VALVES

- A. Manufacturers:
1. American Wheatley
 2. Apollo Valves
 3. Armstrong International, Inc
 4. ITT Bell & Gossett
 5. Or Approved Equal
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.11 PRESSURE REDUCING VALVES

- A. Manufacturers:
1. American Wheatley
 2. Apollo Valves
 3. Armstrong International, Inc
 4. Caleffi
 5. ITT Bell & Gossett
 6. Taco, Inc
 7. Watts
 8. Zurn
 9. Or Approved Equal
- B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 21 13.
- C. Materials of Construction:
1. Valve Body: Constructed of bronze.
 2. Internal Components: Construct of stainless steel and engineered plastics.
- D. Connections:
1. Soldered: 0.75 inch.
- E. Provide integral RPZ backflow and strainer.
- F. Maximum Inlet Pressure: 100 psi.
- G. Maximum Fluid Temperature: 180 degrees F.
- H. Operating Pressure Range: Between 10 psi and 50 psi.

2.12 REDUCERS

- A. Eccentric reducers shall be used on all water lines with top of reducer level.
- B. Concentric reducers shall be used wherever equipment connections do not conform to pipe sizes.

2.13 UNIONS

- A. Manufacturers:
 - 1. Anvil
 - 2. Victaulic
 - 3. Viking Gourp
 - 4. Ward
 - 5. Or Approved Equal
- B. Unions 2 inches and smaller shall be rated at 150 psi working pressure.
- C. Unions 2.5 inches and larger shall be gasketed flanged connections.
- D. Unions shall be ground joint with brass to iron seat. Gasket material shall be 1/16 inch compressed fiber gasket or approved equivalent.
- E. Flanged unions shall have welding ends.
- F. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings. (The couplings shall serve as unions / disconnect points.)
- G. Provide dielectric unions or waterway fittings with appropriate end connections for the pipe materials in which installed, to isolate dissimilar metals.

2.14 ESCUTCHEONS

- A. Manufacturers:
 - 1. Crane
 - 2. Ferguson
 - 3. Ritter
- B. Escutcheons shall be provided wherever pipes pass through walls, floors, or ceilings.
- C. Escutcheons shall be of sufficient size to cover insulation.
- D. Escutcheons shall be split ring, cast brass, chromium plated type.
- E. Escutcheons shall be designed to cover pipe sleeve projection.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at system high points and as indicated.
- C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- D. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- E. Provide valved drain and hose connection on strainer blowdown connection.
- F. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- G. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
- H. Support pump fittings with floor-mounted pipe and flange supports.
- I. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- J. Pipe relief valve outlet to nearest floor drain.

END OF SECTION 23 21 14

SECTION 23 21 23 HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line pumps.
- B. End-suction pumps.

1.02 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 778 - Standard for Motor-Operated Water Pumps Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- B. Indicate dimensions, weight, power and control wiring diagrams, piping connections, etc.
- C. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- D. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.
- B. Source limitation: All pumps shall be provided by a single manufacturer.
- C. Equipment provider shall be responsible for providing certified equipment start-up and, when noted, an in the field certified training session. New pump start-up shall be for the purpose of determining pump alignment, lubrication, voltage, and amperage readings. All proper electrical connections, pump's balance, discharge and suction gauge readings, and adjustment of head, if required. A copy of the start-up report shall be made and sent to both the contractor and to the Engineer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store materials in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage. Cover open ends of all equipment to prevent dust from entering.
- B. Use all means necessary to protect equipment before, during, and after installation.
- C. All scratched, dented, and otherwise damaged units shall be repaired or replaced as directed by the Architect Engineer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Armstrong Pumps Inc
- B. Bell & Gossett, a Xylem Inc. brand
- C. Grundfos Pumps Corporation: www.grundfos.com/#sle.
- D. Patterson
- E. Taco

2.02 GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading throughout the complete curve of the selected impeller and nameplate motor horsepower, and operate within 25 percent of midpoint of published maximum efficiency curve.

- B. Electrical Requirements:
 - 1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.
 - 2. Variable Frequency Drives (VFDs): Provide in accordance with Section 23 09 34, except for integral-VFDs.
 - 3. Enclosures: Provide unspecified product(s) required to fit motor:
- C. All pumps shall be provided with a motor starter or variable frequency drive (VFD) to match motor horsepower and electrical characteristics, refer to the schedule.
- D. All pumps shall be supplied with a triple duty valve or check valve, circuit setter, and isolation/balancing valve. All valves shall be sized such that the pressure drop does not exceed 5 ft at the design flow; not size on pump suction or discharge. Pumps shall be supplied with suction diffusers and flexible connections.
- E. All pumps controlled by VFDs shall be provided with inverter duty motors and shaft grounding rings.
- F. All equipment shall meet or exceed all requirements as described in the latest version of ASHRAE Standard 90.1 and the North Carolina Building Energy Code.
- G. Pumps shall comply with the DOE 10 CFM Parts 429 and 431 for Pump Energy Index (PEI) requirements.

2.03 IN-LINE PUMPS

- A. Closed-Coupled, Single-Stage Pump: Vertical pump with radially- or horizontally-split casing; rated for discharge pressures up to 175 psi.
- B. Casing: Cast iron, with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
- C. The pump shall have a factory installed vent/flush line to ensure removal of trapped air and mechanical seal cooling. The vent/flush line shall run from the seal chamber to the pump discharge. A filter or sediment separator shall be provided in the vent/flush line.
- D. The pump casing shall be drilled and tapped for gauge ports at both the suction and discharge flanges and for drain port at the bottom of the casing.
- E. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- F. Shaft: Stainless steel with stainless steel impeller cap screw or nut and stainless steel sleeve.
- G. Seal: Mechanical seal, 225 degrees F maximum continuous duty temperature.
- H. Support Stand: For floor mounted pumps, provide optional factory support stand.
- I. Electrical:
 - 1. Motor: 1,750 rpm, open drip-proof (ODP); see Section 23 05 13.

2.04 END-SUCTION PUMPS

- A. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 175 psi maximum working pressure.
- B. Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.
- C. The pump shall have a factory installed vent/flush line to ensure removal of trapped air and mechanical seal cooling. The vent/flush line shall run from the seal chamber to the pump discharge. A filter or sediment separator shall be provided in the vent/flush line.
- D. The pump casing shall be drilled and tapped for gauge ports at both the suction and discharge flanges and for drain port at the bottom of the casing.
- E. Impeller: Stainless steel, balanced, fully enclosed, keyed to shaft.
- F. Bearings: Grease lubricated roller or ball bearings. Bearing assemblies shall be interchangeable in several size pumps.
- G. Shaft: Stainless steel with stainless steel shaft sleeve.

- H. Seal: Mechanical, 225 degrees F maximum continuous duty temperature.
- I. Bearing assembly with seal and impeller shall be removable without disturbing pipe connections or moving the motor. The base-mounted pumps shall be foot supported with center drop out spacer coupling for back pull-out.
- J. Drive: Flexible coupling with OSHA approved coupling guard.
- K. Baseplate: Cast iron or fabricated steel with integral drain rim.
- L. Electrical:
 - 1. Motor: 1,750 rpm, total-enclosed, fan-cooled (TEFC); see Section 23 05 13.
 - 2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide one mechanical seal for each model type of pump.
- C. Provide temperature and pressure gauges where and as detailed or directed.
- D. Pumps shall be protected during construction. Keep moisture, refuse, dust, and other loose particles away from the pump and ventilating openings of the motor.
- E. Piping at all pumps shall be independently supported such that flanged connections are not unduly stressed with the entire weight of the piping system.
- F. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- G. On systems where pump seals require flushing water or cooling water for a heat exchanger kit, provide cooling water supply piping and connections as well as the return piping, if required. Piping should be of adequate size to pass required flow rate.
- H. Provide an adequate number of isolation valves for service and maintenance of the system and its components.
- I. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.
- J. On components that require draining, contractor must provide piping to and discharging into appropriate drains.
- K. The Contractor is to ensure that pump nameplate data includes manufacturer's name, pump model number, pump serial number, capacity, head, horsepower, RPM and voltage.
- L. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- M. Check, align, and certify alignment of base-mounted pumps prior to start-up.
- N. Base-mounted pumps shall be mounted on structural steel sub-base.
- O. Install base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00.
- P. Variable Speed Pumps: Pump and motor shall have the ability to operate at 5% over the scheduled speed using a VFD without affecting the warranty or causing damage to the pump or motor. Motors shall have shaft grounding ring.
- Q. Constant Speed Pumps: Pull and trim the pump impeller after a proportional balance has been done by the Balance Contractor. Hydronic systems shall be balanced in a manner to first minimize throttling losses; then the pump impeller shall be trimmed. A balance report from the installer shall

be furnished to the Code Enforcement Official and a copy included in the Operating and Maintenance Manual.

- R. Controls Human-Machine Interface (HMI): HVAC control system; see Section 23 09 23.

END OF SECTION 23 21 23

**SECTION 23 25 00
HVAC WATER TREATMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Materials.
 - 1. System cleaner.
 - 2. Closed system treatment (water).
- B. By-pass (pot) feeder.

1.02 SUBMITTALS

- A. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- B. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- C. Submit directly to Owner, Material Safety Data Sheets (MSDS) for all chemicals used in chemical treatment systems. Include with MSDS written notice of Owner's responsibility to notify its employees of the use of those chemicals.
- D. The Mechanical Contractor shall provide the water treatment subcontractor with a calculated water volume (gallons) of the hydronic system(s) for the cleaning and flushing procedure and the required flow rate (GPM) to remove debris, slag and/or surface corrosion byproducts. This data shall be included in the submittal.
- E. Certificate: Submit certificate of compliance from Authority Having Jurisdiction indicating approval of chemicals and their proposed disposal.
- F. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum ten years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

1.04 WATER ANALYSIS

- A. Submit complete water analysis and results of performance test of each system signed by manufacturer's service representative.
- B. Water analysis shall include the following:
 - 1. Hot Water and Chilled Water
 - a. Hardness
 - b. pH
 - c. "M" alkalinity
 - d. Inhibitor level
 - e. Total dissolved solids
 - f. Temperature

1.05 WATER QUALITY REQUIREMENTS

- A. Minimum water quality requirements for closed hot and/or chilled water systems shall be as follows:
 - 1. pH 8.0-9.0
 - 2. TDS < 500 ppm
 - 3. Hardness as CaCO₃ and Alkalinity < 120 ppm
 - 4. Chlorides < 200 ppm

- | | | |
|-----|---------------------------------|------------------|
| 5. | Suplhates | < 200 ppm |
| 6. | Iron | < 0.5 ppm |
| 7. | Dissolved Oxygen | < 0.1 ppm |
| 8. | Ryznar Index | > 6.0 |
| 9. | Suspended solids | < 10 micron |
| 10. | Bacteria Counts | |
| a. | Total aerobic bacteria counts | < 100 cfu per mL |
| b. | Total anaerobic bacteria counts | < 10 cfu per mL |

1.06 DESIGN CRITERIA

- A. Chemicals shall be suitable for pipe material, fluid medium, and intended treatment.
- B. Provide initial chemical treatment and equipment for all systems based on complete system fluid analysis including makeup water prior to installation.
- C. Initial supply of chemicals for treatment of each system shall be sufficient for start up and testing period, for the time the systems are operated by the Contractor for temporary heating and cooling, and for one year after start-up of system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. AmSolv-Amrep, Inc
- B. Aqua-Chem
- C. Aqualine
- D. ChemTreat
- E. GE Water & Process Technologies
- F. Water Guard
- G. Nalco Company
- H. Or Approved Equal

2.02 MATERIALS

- A. System Cleaner:
 - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.
 - 2. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite or microbiocides such as quarternary ammonia compounds, tributyltin oxide, methylene bis (thiocyanate).
- B. Closed System Treatment (Water):
 - 1. Sequestering agent to reduce deposits and adjust pH.
 - 2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
 - 3. Conductivity enhancers; phosphates or phosphonates.

2.03 BY-PASS (POT) FEEDER

- A. Manufacturers:
 - 1. Griswold Controls
 - 2. J. L. Wingert Company
 - 3. Neptune, a brand of the Dover Company
 - 4. Advantage Controls
 - 5. Or Approved Equal
- B. 5 gallon quick opening cap for working pressure of 175 psi.
- C. Provide cartridge filter.

PART 3 EXECUTION

3.01 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.
- D.

3.02 CLEANING SEQUENCE

- A. Concentration:
 - 1. As recommended by manufacturer.
- B. Chilled Water Systems (use the more stringent between the method below and manufacturer's recommended method):
 - 1. Circulate for 48 hours, then drain systems as quickly as possible.
 - 2. Refill with clean water, circulate for 24 hours, then drain.
 - 3. Refill with clean water and repeat until system cleaner is removed.
- C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer and Owner.
- D. Remove, clean, and replace strainer screens.
- E. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
- F. After the precleaning is complete, test by the water treatment consultant shall confirm and a written report shall certify the completeness of the precleaning by meeting the following minimum requirements:

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Contractor shall install a BYPASS pipe wherever needed between the hydronic return & supply lines to recirculate the entire system using the hydronic pumps installed. The diameter of this pipe shall be at least 1/3 of the diameter of the main hydronic lines. The contractor shall also remove or cap the temporary BYPASS to a permanent configuration when flushing is complete and approved water chemistry is achieved.
- C. Contractor shall remove all strainer screens prior to flushing all systems, including mud from the dirt legs. Contractor shall clean and replace/reinstall all strainer screens after the final cleaning and flushing procedure has passed the final test criteria noted herein.
- D. Complete circulation must be achieved during the cleaning procedure. The Contractor shall develop a plan to achieve a minimum velocity of three feet per second (3 ft/s) in the pipes to ensure the cleaning chemicals will work properly. If necessary, isolate parts of the piping system to attain at least (3 ft/s) in piping being flushed. All electric, pneumatic, and thermostatic operated valves shall be full open. All deadend runs shall be looped together with piping not less than one-third the size of the run.

3.04 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.05 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
 - 1. Provide minimum of four hours of instruction for two people.
 - 2. Have operation and maintenance data prepared and available for review during training.

3. Conduct training using actual equipment after treated system has been put into full operation.
- B. Written completeness certification and applicable reports will be forwarded to the project Engineer prior to acceptance.

3.06 MAINTENANCE

- A. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.
- B. Provide monthly technical service visits to perform field inspections and make water analysis on-site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- C. Provide laboratory and technical assistance services during this maintenance period.
- D. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

END OF SECTION 23 25 00

SECTION 23 64 23 SCROLL WATER CHILLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air-cooled scroll water chillers.

1.02 REFERENCE STANDARDS

- A. AHRI 550/590 (I-P) - Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle 2023.
- B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.
- C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2021.
- E. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus 2019.
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- G. UL 1995 - Heating and Cooling Equipment Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Architect of any major deviations from the equipment originally specified prior to ordering equipment.

1.04 SUBMITTALS

- A. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- B. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
- C. Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers.
- D. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- E. Warranty:
 - 1. Provide minimum five (5) year warranty (parts and labor) for compressors.
 - 2. Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B. When required, provide certification of inspection in compliance with the requirements of Authority Having Jurisdiction.

1.06 COORDINATION

- A. If equipment is supplied by a manufacturer other than the one named, coordinate with the General Contractor and affected subcontractors to ensure the specified performance is met.
- B. The Mechanical Contractor shall be responsible for costs incurred by the General Contractor, Subcontractors, and Consulting Engineers to accommodate units furnished by a manufacturer

other than manufacturer named as basis of design. This includes, but is not limited to the following:

1. Structural supports for units.
2. Size and location of concrete bases/housekeeping pads
3. Piping size and connection/header locations
4. Interference with existing or planned piping and wiring
5. Electrical power requirements and wire/conduit and over current protection sizes.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's written installation instructions for rigging, unloading, and transporting units.
- B. Deliver units to the job site completely assembled and charged with refrigerant and oil by manufacturer.

1.08 WARRANTY

- A. Manufacturer's Warranty: Provide minimum five year warranty to include coverage for materials and labor for compressor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Carrier, a part of UTC Building and Industrial Systems, a unit of United Technologies Corp
- B. ***Daikin Applied (ADD 01)***
- C. Trane, a brand of Ingersoll Rand
- D. York International Corporation/Johnson Controls, Inc
- E. Or Approved Equal

2.02 AIR-COOLED SCROLL WATER CHILLERS

- A. Chillers: Factory assemble and test chiller consisting of compressor(s), compressor motor(s), evaporator, condenser, enclosure, refrigeration circuits(s) and specialties, interconnecting piping, starters, and microprocessor-based controls.
 1. Rating: AHRI 550/590 (I-P).
 2. Refrigerant: HFC-410A.
 3. Safety: UL 1995 and ASHRAE Std 15.
 4. Construction & Testing: ASME BPVC-VIII-1 as applicable for construction type.
 5. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the Authority Having Jurisdiction as suitable for the purpose specified and indicated.
 6. Energy Efficiency: ASHRAE Std 90.1.
 7. Enclosures:
 - a. Frame:
 - 1) Heavy-gauge steel.
 - 2) Factory apply hot-dipped galvanized or air-dried paint finish.
 - b. Steel Chiller Cabinets:
 - 1) Factory apply baked-on enamel or baked-on powder paint finish.
 - 2) Perform 500-hour minimum salt spray test in accordance with ASTM B117.
 - c. Electrical Equipment: NEMA 250 or UL 1995 as applicable.

2.03 COMPRESSORS AND EVAPORATOR

- A. Compressors: Hermetic scroll type.
 1. Unit: Fully hermetic type with multiple, direct-drive compressors with discharge and suction service valves.
 2. Oil Lubrication System: Initial oil charge, oil sump, heater, oil level, and sight glass.
 3. Capacity Reduction System: Compressor staging with control down to 12 percent of full load without the activation of hot gas by-pass.
 4. Each compressor shall have crankcase heaters installed and properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

- B. Evaporator: Provide shell and tube or brazed plate type.
 - 1. Shell and Tube Type:
 - a. Shell, removable heads and tube support sheets constructed of carbon steel.
 - b. Tubes: Mechanically expand and fasten, seamless, externally or internally enhanced, copper tubes into intermediate tube support sheets along the length of shell to avoid contact and relative motion between tubes.
 - c. Refrigerant Working-Side Pressure Rating: 400 psig minimum.
 - d. Water Working-Side Pressure Rating: 150 psig minimum.
 - e. Provide with grooved connections.
 - f. Insulation for all cold surfaces.
 - 1) Insulation is factory installed on shell, connections, and suction piping.
 - 2) 1.5 inches minimum thick, closed cell, expanded polyvinyl chloride, polyurethane, or vinyl nitrate polymer insulation with a maximum k value of 0.28.
 - g. Provide factory installed vents and water drain connections on evaporator or piping.
 - h. Freeze Protection for Outdoor Locations: Provide thermostatically controlled electric heater to protect from freezing at ambient temperatures down to minus 20 degrees F.
 - 2. Brazed Plate Type:
 - a. Refrigerant Working-Side Pressure Rating: 430 psig minimum.
 - b. Water Working-Side Pressure Rating: 150 psig minimum.
 - c. Provide with grooved connections.
 - d. Insulation for all cold surfaces.
 - 1) Insulation is factory or field installed on evaporator, connections, and suction piping.
 - 2) 1.5 inches minimum thick, closed cell, expanded polyvinyl chloride, polyurethane, or Armaflex II insulation with a maximum k value of 0.28.
 - e. Provide factory or field installed vents and water drain connections on evaporator or piping.
 - f. Provide factory or field installed fittings for temperature control sensors on evaporator or piping.

2.04 AIR-COOLED CONDENSER AND FANS

- A. Provide finned-tube, brazed one-piece, or flat tube-plate-manifold type.
 - 1. Finned-tube Type:
 - a. Mechanically bond aluminum fins to copper tubing and protect with corrosion resistant materials or coatings.
 - b. Clean, dehydrate and test.
 - c. Leak Test: 650 psig minimum.
 - 2. Brazed One-piece Type:
 - a. Construct of same material to avoid galvanic corrosion.
 - b. Braze coils and headers as one assembly.
 - c. Clean, dehydrate and test.
 - d. Leak Test: 650 psig minimum.
 - 3. Flat Tube-plate-manifold Type:
 - a. Construct all components of same aluminum alloy to avoid galvanic corrosion.
 - b. Braze manifolds, flat tubes and fin-plates together to form single coil assembly.
 - c. Clean, dehydrate and test.
 - d. Leak Test: 656 psig minimum.
- B. Coil Guards: Provide corrosion proof, louvered panels, factory installed. Provide coil protection for shipping by enclosing entire condenser coil with heavy plastic to prevent coil damage during shipping or rigging.
- C. Fans and Motors:
 - 1. Fans: Dynamically balance propeller or airfoil type fans of reinforced polymer or glass fiber reinforced composite corrosion resistant construction equipped with sealed, permanently lubricated ball bearings.
 - 2. Discharge Fan Guards: Corrosion resistant, heavy gauge, steel wire.

3. Discharge Direction: Vertical.
4. Motors: Direct drive, totally enclosed for outdoor use with current overload protection.
5. Unit shall be capable of starting and running at outdoor ambient temperatures from 32F to 125F for all sizes.

2.05 REFRIGERATION CIRCUITS

- A. Provide multiple independent refrigeration circuit(s) with one or multiple compressor(s) per circuit.
- B. Provide liquid line shut-off valve, filter-drier, expansion valve, and refrigerant relief device for each independent circuit.

2.06 INTEGRATED MICROPROCESSOR BASED DDC CONTROLS PACKAGE

- A. Pre-wire, assemble, factory mount, and test operating and safety control system consisting of a digital display or gauges, on-auto-off switch, motor starters, disconnect switches, circuit breaker, power and control wiring. The control panel shall have an SSCR rating of 65 kA. Provide controls, monitoring, programmable set-points, alarms, and BAS as defined below:
 1. Automatic Adjustable Operating Controls:
 - a. Temperature of chilled water leaving chiller.
 - b. Chiller system capacity control based on set-points and system load.
 - c. Compressor short-cycling prevention.
 - d. Lead/lag for multiple compressors.
 - e. Automatic reset on power source failure.
 - f. Load limiting.
 - g. Sequencing of condenser fans.
 2. Normal Operation Monitoring and Open Cover-less Displays:
 - a. Hours of operation.
 - b. Suction and discharge refrigerant pressures.
 - c. Automatic diagnostics.
 - d. Number of starts.
 - e. On/off compressor status.
 - f. Entering and leaving chilled water temperatures.
 - g. Status of operation.
 - h. Weekly purge cycle totalization if applicable.
 - i. Oil pressure.
 3. Set-Points:
 - a. Leaving chilled water temperature.
 - b. Date/time.
 4. Automatic Chiller Shut-Down Safety Controls and Alarm:
 - a. Automatic Reset:
 - 1) Chilled water flow interlock.
 - 2) Voltage protection (over/under).
 - 3) Phase reversal protection.
 - b. Manual Reset:
 - 1) Evaporator low pressure.
 - 2) High motor winding temperature.
 - 3) Low chilled water temperature.
 - 4) Low chilled water flow.
 - 5) High condenser refrigerant discharge pressure.
 - 6) Motor current overload and phase loss.
 - 7) Low oil flow.
 - c. Remote Alarm: Activate remote, audible bell upon safety shutdown of chiller.
 5. Building Automation System (BAS) Communications via Shielded Cable:
 - a. Minimum Data Transmission to BAS:
 - 1) All system operating conditions.
 - 2) Capacity control information.
 - 3) Safety shutdown conditions.

- b. Minimum Operating Commands from BAS:
 - 1) Remote unit start/stop.
 - 2) Remote chilled water reset.
 - c. Provide BACnet gateway. Provide BIBBs with submittal.
- B. The unit shall have a machine mounted control console in a weatherproof box containing the following:
 - 1. System emergency stop switch.
 - 2. Oil failure switch (manual reset).
 - 3. Water freeze protection.
 - 4. High and low pressure cutouts.
 - 5. Pump down controls.
 - 6. Water temperature control thermostat.
- C. Each unit shall include a positive acting timer to prevent short cycling of compressors and to delay restart of compressors after shutdown.
- D. On all units, source of control circuit power shall be completely independent of unit power source.
- E. The power and control cabinet shall be machine mounted in a weatherproof box containing the following:
 - 1. Circuit breaker with three phase protection.
 - 2. Starting contactors.
 - 3. Control terminal block.
 - 4. Power terminal block.
 - 5. Power wiring.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Align chiller package on steel or concrete foundations.
- C. The unit shall be set into place on a concrete pad with neoprene type vibration isolators, leveled, piped, wired, and controlled as shown on the plans and as required by the manufacturer. Connect all water piping so chiller and water circuits are serviceable.
- D. Furnish and install taps for thermometers and pressure gauges in water piping adjacent to inlet and outlet connections of evaporator. Make taps completely weatherproof yet accessible.
- E. Insulate evaporator and any other portion of machine required to prevent sweating and/or freezing under normal operating conditions.
- F. Furnish and install all necessary controls external to unit, including all interlock wiring and interface with the building control system.
- G. A factory representative shall be present at the job site for a period of two working days to supervise the testing, dehydrating, charging and start up of the chiller, and he shall instruct the Owner's representative in the operation of the chiller.
- H. Connect to electrical service.
- I. Connect to chilled water piping.
- J. Arrange piping for easy dismantling to permit tube cleaning and removal.
- K. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and BAS Controller.

3.02 MANUFACTURER'S FIELD SERVICES

- A. Perform factory startup of the chiller by factory trained and authorized servicing technicians confirming equipment has been correctly installed prior to equipment becoming operational and covered under the manufacturer's warranty.
- B. Supply initial charge of refrigerant and oil if not completely factory charged.

- C. Demonstrate system operations and verify specified performance.

3.03 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, and maintenance of each component.
- B. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of one day of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.
 - 5. Provide video recording of the training session. Turn over video to Owner at the conclusion of the project.
- C. The Contractor, upon completion of the project, shall prepare an as-built control diagram on a non-fading paper. The diagram shall be installed in a glassed frame and hung on the mechanical room wall.

END OF SECTION 23 64 23

**SECTION 26 01 00
ELECTRICAL GENERAL PROVISIONS**

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Contractor shall provide all materials, equipment and labor necessary to install and set into operation the electrical equipment as shown on the Engineering Drawings and as contained herein.

1.02 QUALITY ASSURANCE

- A. See the General and Supplementary General Conditions and Architectural Divisions.
- B. All work shall be in accordance with the North Carolina State Building Code, which includes the 2020 edition of the National Electrical Code.
- C. The Contractor shall be responsible for obtaining all permits and shall notify inspection departments as work progresses.
- D. Wherever the words "Approved", "Approval", and "Approved Equal" appear, it is intended that items other than the model numbers specified shall be subject to the approval of the Engineer.
- E. "Provide" as used herein shall mean that the Contractor responsible shall furnish and install said item or equipment. "Furnish" as used herein shall mean that the Contractor responsible shall acquire and make available said item or equipment and that installation shall be by others. "Install" as used herein shall mean that the Contractor responsible shall make installation of items or equipment furnished by others.
- F. All personnel under this Contractor's supervision shall be qualified to perform those portions of the work assigned to them. Personnel (including project managers) deemed to be negative to the overall success of the project shall be removed from the project and replaced with qualified personnel who will be positive for the project. Upon written notification that particular personnel have been deemed negative to the overall success of the project, this Contractor shall immediately replace such particular personnel. The engineer shall be sole arbiter and any decision regarding fitness of this Contractor's personnel for this project shall not be subject to appeal.

1.03 SUBMITTALS

- A. See General and Supplementary General Conditions and Division 1.
- B. Within ten (10) days after notification of the award of the Contract and written notice to begin work, the Contractor shall submit for approval to the Architect/Engineer a detailed list of equipment and material which he proposes to use.
- C. The Contractor shall provide an electronic pdf copy of the submittal data on the products, methods, etc. proposed for use on the project. The submittal shall contain complete submittal data on all products, methods, etc. proposed for use on the project.
- D. Each submittal shall bear the approval of the Contractor indicating that he has reviewed the data and found it to meet the requirements of the specifications as well as space limitations and other project conditions. The submittals shall be clearly identified showing project name, manufacturer's catalog number and all necessary performance and fabrication data. Detailed submittal data shall be provided when items are to be considered as substitution for specified items. Acceptance for approval shall be in writing from the Engineer.
- E. The Contractor shall submit to the Engineer a set of accurately marked-up plans indicating all changes encountered during the construction. Final payment will be contingent on receipt of these as-built plans.
- F. The Contractor shall furnish an electronic copy of maintenance and operating instructions.
- G. The Contractor shall submit to the Engineer a duplicate set of final electrical inspection certificates prior to final payment.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All material and equipment shall be delivered and unloaded by the Contractor within the project site as noted herein or as directed by the Owner.
- B. The Contractor shall protect all material and equipment from breakage, theft or weather damage. No material or equipment shall be stored on the ground.
- C. The material and equipment shall remain the property of the Contractor until the project has been completed and turned over to the Owner.
- D. Where equipment cannot be stored at the site due to exposure to the elements or lack of storage space, the contractor shall store all equipment in a bonded warehouse until the time of installation.

1.05 WORK CONDITIONS AND COORDINATION

- A. The Contractor shall review the entire set of plans to establish points of connection and the extent of electrical work to be provided in his Contract.
- B. The contractor is responsible for reviewing the complete set of contract documents. Coordinate all phasing requirements with architectural drawings. Coordinate equipment locations and utility routing with all trades to ensure code compliance and constructibility.
- C. This Contractor shall be responsible for all electrical work and make final connections to equipment installed in his Contract.
- D. Pipe, conduit and duct chases required for installation of work shall be provided by the General Contractor unless otherwise noted. This Contractor shall be responsible for coordinating the location of all required chases.
- E. All work shall be coordinated with other trades. Cutting of new work and subsequent patching shall be approved by Architect/ Engineer and shall be at the Contractor's expense with no extra cost to the Owner.

1.06 GUARANTEE

- A. See the General and Supplementary General Conditions.
- B. Where extended warranties or guarantees are available from the manufacturer, the Contractor shall prepare the necessary Contract Documents to validate these warranties as required by the manufacturer and present them to the Architect/Engineer.

PART 2 PRODUCTS

2.01 MATERIAL QUALITY

- A. Material and equipment shall be new, unless noted otherwise, of the highest grade and quality and free from defects or other imperfections. Material and equipment found defective shall be removed and replaced at the Contractor's expense.

2.02 EQUIPMENT LISTINGS

- A. All materials and equipment shall be third party listed by an agency accredited by the NCBCC and NC Department of Insurance (NC DOI). The list of accredited agencies may be obtained on NCDOL's web site.

PART 3 EXECUTION

3.01 INSPECTION

- A. If any part of this Contractor's work is dependent for its proper execution or for its subsequent efficiency or appearance on the character or conditions of contiguous work not executed by him, the Contractor shall examine and measure such contiguous work and report to the Architect or Engineer in writing any imperfection therein, or conditions that render it unsuitable for the reception of this work. Should the Contractor proceed without making such written report, he shall be held to have accepted such work and the existing conditions and he shall be responsible for any defects in this work consequent hereon and will not be relieved of the obligation of any guarantee because of any such imperfection or condition.
- B. After the designer pre-final inspection and confirmation that the final punch list items have been completed. The contractor shall schedule a final electrical inspection with the SCO office. Inspections shall be Monday through Friday unless specifically coordinated with the SCO office.

3.02 INSTALLATION

- A. All work shall be performed in a manner indicating proficiency in the trade.
- B. All conduit, pipes, ducts, etc., shall be either parallel to building walls or plumb where installed in a vertical position and shall be concealed when located in architecturally finished areas.
- C. Any cutting or patching required for installation of this Contractor's work shall be kept to a minimum. Written approval shall be required by the Architect/Engineer if cutting of primary structure is involved.
- D. All patching shall be done in such a manner as to restore the areas or surfaces to match existing finishes.
- E. The Contractor shall lay-out and install his work in advance of pouring concrete floors or walls. He shall furnish and install all sleeves or openings through poured masonry floors or walls above grade required for passage of all conduits, pipes or duct installed by him. The Contractor shall furnish and install all inserts and hangers required to support his equipment.
- F. The Contractor shall be responsible for removing all spray-on fireproofing overspray from all equipment, light fixtures, and all other materials provided as part of the electrical contract.

3.03 PERFORMANCE

- A. The Contractor shall perform all excavation and backfill operations necessary for installation of his work.
- B. Rock excavation shall be defined in the Supplementary General Conditions, Division 1 or Division 2. Unless specifically stated, neither rock excavation nor a unit price for rock excavation shall be required in the bid.

3.04 ERECTION

- A. All support steel, angles, channels, pipes or structural steel stands and anchoring devices that may be required to rigidly support or anchor material and equipment shall be provided by this Contractor.

3.05 FIELD QUALITY CONTROL

- A. The Contractor shall conform to the requirements of Division 3 for concrete testing.
- B. The Contractor shall test his entire installation and shall furnish the labor and materials required for these tests. Tests shall be performed in accordance with the requirements of the particular section of the specifications and in accordance with the requirements of the State Ordinances and Codes, and the National Electrical Code. The Contractor shall notify the Architect or Engineer of his readiness for such test. A final inspection by the Electrical Inspector or Local Authority Having Jurisdiction is required, and an inspection certificate is required prior to authorization of final payment.
- C. Testing required for compliance with the Contract shall be stated in subsequent sections.
- D. All tests specified shall be completely documented indicating time of day, date, temperature and all other pertinent test information including the entity conducting the test.
- E. All required documentation of readings required by each test shall be submitted to the Engineer prior to, and as one of the prerequisites for, final acceptance of the project.

3.06 ADJUST AND CLEAN

- A. All equipment and installed materials shall be thoroughly clean and free of all dirt, oil, grit, grease, etc.
- B. Factory painted equipment shall not be repainted unless damaged areas exist. These areas shall be touched up with a material suitable for the intended service. In no event shall nameplates be painted.
- C. At a scheduled meeting, the Contractor shall instruct the Owner or the Owner's representative in the operation and maintenance of all equipment installed under his Contract (in the presence of the Engineer).

3.07 MAINTENANCE AND OPERATING MANUAL

- A. The Contractor shall prepare an electronic submission of a manual describing the proper maintenance and system operation. This manual shall not consist of standard factory printed data intended for dimension or design purposes (although these may be included), but shall be prepared to describe this particular job. This manual shall include the following:
- B. Data on all equipment as listed on the fixture and equipment schedules on the plans. Also data on all fire alarm, telephone system, public address system, security system, lighting control systems, CCTV, MATV, CATV, generator, battery backup system, etc. that are applicable for the project.
- C. Warranties as required for each product.
- D. A check list for periodic maintenance of all equipment requiring maintenance. (i.e., fire alarm system, security system, generator, battery backup system, etc.)
- E. Maintenance and spare parts data for all equipment.
- F. As-Built wiring for equipment containing field wired systems. (i.e., fire alarm, security, data system, CATV, telephone, public address, etc.)
- G. The manuals shall be dated and signed by the Contractor when completed.
- H. The operating and maintenance manuals shall be submitted to the Engineer for approval. When the manuals are considered complete by the Engineer, they will be turned over to the Owner for their permanent use.

END OF SECTION 26 01 00 26 01 00

**SECTION 26 05 05
ELECTRICAL DEMOLITION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as indicated.
- B. Report discrepancies to Architect before disturbing existing installation.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- 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 Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 48 hours before de-energizing system.
- E. Fire alarm system shall be maintained to all occupied portions of the building.
 - 1. Notify Owner and Fire Marshall a least 48 hours before partially or completely disabling system.
 - 2. If the Fire alarm system cannot be maintained in the occupied portion of the building contractor shall provide a fire watch in accordance with NFPA 72 and local authority requirements.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Lamps are to be disposed of in accordance with NC G.S. 130A - 310.60. Applicable equipment and materials include, but are not limited to:
 - 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
 - 2. PCB- and DEHP-containing lighting ballasts.
 - 3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Where conduit cannot be removed from floors or walls, cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.

- G. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- H. Remove all devices from walls or ceilings shown to be removed on the Architectural drawings wether shown on the electrical demolition plans or not.
- I. Where existing downstream devices are to remain, extend existing branch circuit conduit and conductors to maintain service.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.

END OF SECTION 26 05 05

SECTION 26 05 19 POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Underground feeder and branch-circuit cable.
- C. Service entrance cable.
- D. Wiring connectors.
- E. Electrical tape.
- F. Oxide inhibiting compound.
- G. Wire pulling lubricant.

1.02 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire 2013 (Reapproved 2018).
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft 2011 (Reapproved 2017).
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes 2010, with Editorial Revision (2020).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation 2004 (Reapproved 2020).
- E. NFPA 70 - National Electrical Code; National Fire Protection Association, Including All Applicable Amendments and Supplements; 2020.

1.03 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- B. Field Quality Control Test Reports.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing of exterior below grade conduit and associated hand holes or man holes..
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1.04 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- C. Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.06 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Service entrance cable is not permitted.
 - 1. For underground service entrance, installed in raceway.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. All conductors shall be labeled two feet on centers indicating size, type, voltage, rating, and manufacturer's name.
- D. Provide new conductors and cables manufactured not more than one year prior to installation.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- F. Comply with NEMA WC 70.
- G. Conductor Material:
 - 1. Provide copper conductors except where aluminum conductors are specifically indicated. Substitution of aluminum conductors for copper is not permitted. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors.
 - 3. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors.
- H. Minimum Conductor Size: 12 AWG.
- I. Maximum Conductor Size: 500 kcmil
- J. Conductors for branch circuits shall be sized to prevent a voltage drop exceeding three percent (3%) at the farthest outlet of power, heating and lighting loads, or any combination of such loads. The maximum total voltage drop on both feeders and branch circuits to the farthest outlet shall not exceed five percent (5%).
 - 1. Where the branch circuit conductor length from the panel to the first outlet on a 277 volt circuit exceeds 125 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG. Increase the branch circuit conductor size an additional wire size for each 125' of additional length of the entire circuit. The ground conductor size shall be increased proportionately to the increase in the phase conductors per 2020 NEC 250.122(B).
 - 2. Where the conductor length from the panel to the first outlet on a 120 volt circuit exceeds 50 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG. Increase the branch circuit conductor size an additional wire size for each 100' of additional length of the entire circuit. The ground conductor size shall be increased proportionately to the increase in the phase conductors per 2020 NEC 250.122(B).
- K. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method:
 - a. Conductors #10 AWG and smaller shall be factory color coded.
 - b. Conductors #3 and larger shall be factory color coded on the entire length.

3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.
 - d. 0 - 10V Dimming conductors: Violet and Grey

2.03 BUILDING WIRE

- A. Approved Manufacturers as listed below or approved equal:
 1. Copper or Aluminum Building Wire:
 - a. Triangle
 - b. Okonite
 - c. Houston Wire and Cable
 - d. or approved equal
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Class B Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 1. Copper Building Wire: Type THHN/THWN or XHHW-2.
 2. Conductors routed on roofs or other exterior surface where raceway is exposed to direct sunlight shall be type XHHW-2 insulation.
 3. Aluminum Building Wire (only where specifically indicated or permitted for substitution): Type XHHW-2.

2.04 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C. Wiring Connectors for Splices and Taps:
 1. Splices or taps shall not be allowed for feeder conductors unless specifically noted on plans.
 2. Where a splice or tap for feeder conductors is noted on the plans, connectors shall be Blackburn insulated multi-tap or approved equal.
 3. Splices in branch circuit conductors shall be allowed in accessible junction boxes, troughs, or gutters.
 - a. Copper Conductors #10 AWG and smaller: Use twist-on insulated spring connectors.
 - b. Copper Conductors #8 AWG and larger: Use mechanical connectors with gum rubber tape or friction tape. Solderless mechanical connectors with UL listed insulating covers may be used at contractor's option.
 4. Use of split bolts is not allowed.
 5. "Sta-kon" or other permanent type crimp connectors shall not be used for branch circuit connections.
- D. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
- E. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

2.05 ACCESSORIES

- A. Electrical Tape:
1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 - a. Product: Okonite 2000 or approved equal.
 2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
- B. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
- C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
1. Circuit routing indicated is diagrammatic.
 2. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 3. 0 - 10V lighting dimming conductors may not be routed in the same raceway with line voltage conductors.
 4. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 5. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
 6. A dedicated green equipment grounding conductor shall be provided for all raceways containing branch circuit or feeder conductors. Equipment ground conductor shall be sized in accordance with the NEC.
- B. Install products in accordance with manufacturer's instructions.

- C. Install conductors and cable in a neat and workmanlike manner. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- D. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant for conductors #4 AWG or larger, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- G. Install conductors with a minimum of 12 inches of slack at each outlet.
- H. Neatly train conductors inside boxes, wireways, panelboards and other equipment enclosures. Conductors shall not be laced or bundled to avoid overheating.
- I. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- J. Make wiring connections using specified wiring connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 2. Do not remove conductor strands to facilitate insertion into connector.
 - 3. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 - 4. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
- K. Insulate ends of spare conductors using vinyl insulating electrical tape.
- L. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

- A. All tests shall be completely documented indicating time of day, date, temperature and all pertinent test information. All required documentation shall be submitted to the Engineer prior to, and as a prerequisite for, final acceptance of the project. All test results shall be included in the Owner's operation and maintenance manual.
- B. Inspect and test in accordance with NETA ATS, Section 7.3.2.
 - 1. Perform each of the following visual and electrical tests:
 - a. Compare cable data with drawings and specifications to ensure compliance with contract documents.
 - b. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - c. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - d. Inspect compression-applied connectors for correct cable match and indentation.
 - e. Inspect for correct identification.
 - f. Inspect cable jacket and condition.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- C. Insulation resistance test is required for all feeder conductors prior to energizing feeders, sub-feeders, or service entrance conductors.

1. All current carrying feeder phase conductors and neutrals shall be tested as installed, and before connections are made, for insulation resistance and accidental grounds. This shall be done with a 500 volt insulation resistance tester. In the procedures listed below shall be followed:
 - a. Minimum readings shall be one million (1,000,000) or more ohms for #6 AWG wire and smaller, 250,000 ohms or more for #4 AWG wire or larger, between conducts and between conductor and the grounding conductor.
 - b. After all fixtures, devices and equipment are installed and all connections completed to each panel, the Contractor shall disconnect the neutral feeder conductor from the neutral bar and take a insulation resistance reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, the Contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then test each one separately to the panel and until the low readings are found. The Contractor shall correct troubles, reconnect and retest until at 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
 - c. The Contractor shall send a letter to the Engineer certifying that the above has been done and tabulating the insulation resistance readings for each panel. This shall be done at least four (4) days prior to final inspection.
 - d. At final inspection, The Contractor shall furnish a insulation resistance tester and show the Engineer's representatives that the panels comply with the above requirements. He shall also furnish a hook-on type ammeter and voltmeter to take current and voltage readings as directed by the representatives.
 - e. Results of the test shall be made available to the engineer at the required pre-energization walk through.
 2. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- D. Correct deficiencies and replace damaged or defective conductors and cables and re-test as indicated above. Contractor shall submit new test results to the Engineer to demonstrate the deficiency has been corrected.

END OF SECTION 26 05 19

SECTION 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.

1.02 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System 2012.
- B. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings 2022.
- C. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 467 - Grounding and Bonding Equipment Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Field quality control test reports.
- D. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
 - 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- F. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
 - 4. Concrete-Encased Electrode:
 - a. Where metallic structural components meet the definition of a concrete encased electrode as defined in NEC 250.52, the concrete encased electrode shall be bonded to the grounding electrode system per NEC 250.50. Coordinate with the structure prior to pouring concrete foundations.
 - b. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
 - 5. Ground Rod Electrode(s):
 - a. Space electrodes not less than 10 feet from each other and any other ground electrode until maximum allowed resistance to ground is achieved.
 - b. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible,

- locate in softscape (uncovered) area.
- 6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
- 7. Ground Bar: Provide ground bar in main electrical room, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4" x 2" x 18" unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
- 8. unless otherwise noted. Location as identified on plans.
- 9. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.
- G. Service-Supplied System Grounding:
 - 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 - 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- H. Separately Derived System Grounding:
 - 1. Separately derived systems include, but are not limited to:
 - a. Transformers.
 - b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
 - c. Generators, when neutral is switched in the transfer switch.
 - 2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
 - 3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
 - 4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
 - 5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
- I. Bonding and Equipment Grounding:
 - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 - 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 - 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 - 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 - 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
 - c. Metal process piping.
- J. Communications Systems Grounding and Bonding:
 1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: #3/0 AWG.
 - b. Raceway Size: 1" trade size unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4" x 2" x 18" unless otherwise indicated or required.
 - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
 2. Where insulated grounding conductors are used conductors shall be colored solid green.
 3. Grounding electrode conductors #4 AWG and larger shall be installed in raceway.
- C. Connectors for Grounding and Bonding:
 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 3. Unless otherwise indicated, use double crimp compression connectors or exothermic welded connections for accessible connections.
- D. Ground Bars:
 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 2. Size: As indicated elsewhere in this section.
 3. Holes for Connections: All mechanical connectors shall be double hole double crimp compression connectors..
- E. Ground Rod Electrodes:
 1. Comply with NEMA GR 1.
 2. Material: Copper-bonded (copper-clad) steel.
 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.

- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner.
- C. Boxes with concentric, eccentric or oversized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per NEC table 250-122 and lugged to the box.
- D. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle.
 - 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- E. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Compression Connectors: Secure connections using manufacturer's recommended tools and dies. Connectors must be UL listed for use with grounding electrode conductors.
- F. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS Section 7.13.
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Verify that ground system was installed in accordance with the contract documents and NEC Article 250.
 - 3. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
 - 4. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at ground test wells and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without 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.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- C. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- D. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION 26 05 26

**SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- B. Section 26 05 36 - Cable Trays for Electrical Systems: Additional support and attachment requirements for cable tray.
- C. Section 26 05 33.16 - Boxes and Cabinets: Additional support and attachment requirements for boxes.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
- B. Sequencing:

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Anchors and Fasteners:
 - 1. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.

2. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
3. Hollow Masonry: Use toggle bolts.
4. Hollow Stud Walls: Use toggle bolts.
5. Steel: Use beam clamps, machine bolts, or welded threaded studs.
6. Sheet Metal: Use sheet metal screws, bolts, or bolts.
7. Wood: Use wood screws.
8. Plastic and lead anchors are not permitted.
9. Powder-actuated fasteners are not permitted.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 1. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Conduits installed on the interior of exterior building walls shall be spaced off the wall surface a minimum of 1/4 inch using "clamp-backs" or strut.
- I. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. Inspect support and attachment components for damage and defects.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 26 05 29

**SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. PVC-coated galvanized steel rigid metal conduit (RMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Electrical metallic tubing (EMT).
- F. Rigid polyvinyl chloride (PVC) conduit.
- G. Conduit fittings.
- H. Accessories.

1.02 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC) 2020.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S) 2020.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit 2018.
- D. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.
- E. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- G. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT) 2020.
- H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC) 2017.
- I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- B. Project Record Documents: Record actual routing for conduits installed underground exterior to the building envelope.

1.05 QUALITY ASSURANCE

- A. Conduit shall be delivered to the project site in bundles of full length pipes, each length marked with the trademark of the manufacturer and the Underwriters' Laboratories, Inc. stamp. Each conduit length shall be straight, true and free from scales, blisters, burrs and other imperfections.
 - 1. Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications.
- C. Embedded Within Concrete:
 - 1. Within Slab on Grade: Not permitted.
 - 2. Within Slab Above Ground: Not permitted.
 - 3. Within Poured Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
- D. Outdoors: Apply raceways as indicated below unless otherwise noted
 - 1. Above ground conduit: Rigid galvanized steel conduit with 90o rigid elbow below grade transition to PVC.
 - 2. Roof: Rigid galvanized steel conduit supported on rubber blocks and unistrut frame. Conduit must be at least 3-1/2" above roof surface.
 - 3. Feeders: PVC Type DB concrete encased
 - 4. Branch circuits: Schedule 40 PVC direct buried
 - 5. Telecommunications: Schedule 40 PVC concrete encased
 - 6. Connections to vibrating equipment including transformers, generators, and other motor driven equipment: Liquid tight flexible metal conduit.
 - 7. Boxes and enclosures above ground Nema Type 4
 - 8. Where rigid polyvinyl (PVC) conduit is used for feeder conductors, transition to galvanized steel rigid metal conduit a minimum of three feet horizontally prior to emerging from underground.
 - 9. Where rigid polyvinyl (PVC) conduits are used for branch circuits, use galvanized steel rigid metal conduit elbows for bends.
- E. Indoors: Finished spaces (not subject to physical damage)
 - 1. Raceway shall be routed concealed in interior portions of furred spaces, ceilings, and cavities, unless other than concrete or solid plaster where possible.
 - 2. Raceways 2 inch or less shall be allowed to be EMT conduit.
 - 3. All raceways concealed in exterior walls shall be rigid galvanized steel conduit.
 - 4. All raceways larger than 2 inch shall be rigid galvanized conduit.
 - 5. Where surface mounted conduit is required in finished spaces, contractor shall utilize surface metal raceway wire mold.
 - 6. Where there is a transition between RGS in a wall to EMT above ceiling, it shall be made at a junction box above accessible ceiling.
 - 7. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- F. Stub Ups
 - 1. All feeder stub ups shall transition below grade from PVC to rigid a minimum of 3 feet horizontally from stub up location.

2. All branch circuit stub ups, where exposed or in non-CMU walls, shall transition to rigid galvanized steel at 90 degree elbow.
 3. Schedule 40 rigid polyvinyl (PVC) stub ups are only allowed where conduits come up in CMU walls or the bottom of floor mounted equipment.
- G. Unfinished spaces subject to damage (Electrical, Mechanical etc.)
1. All conduit in unfinished spaces shall rigid galvanized steel. Conduit is not considered subject to damage when installed at least 10 feet above finished floor or tight to structure.
 2. Conduits are not required to transition to rigid galvanized steel where they are routed down into panelboards or other wall mounted equipment.
- H. Exposed, Interior finished spaces: Use surface metal raceway as identified on the drawings.
1. Surface metal raceway shall be manufactured by Wiremold or approved equal.
 2. A separate equipment ground conductor shall be run in the surface metal raceway.
- I. Connection to vibrating equipment shall be made with flexible metal conduit or liquid tight flexible metal conduit depending on the environment installed.
- J. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit shall be allowed.
1. Maximum Length: 6 feet.
- K. Connections to Vibrating Equipment:
1. Dry Locations: Use flexible metal conduit.
 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 3. Maximum Length: 6 feet unless otherwise indicated.
 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.
 - c. Generators.

2.02 CONDUIT REQUIREMENTS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Minimum Conduit Size, Unless Otherwise Indicated:
1. Interior: 3/4 inch (21 mm) trade size.
 2. Flexible Connections to Luminaires: 1/2 inch (13 mm) trade size.
 3. Exterior: 1 inch (27 mm) trade size.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
1. Allied Tube & Conduit.
 2. Republic Conduit.
 3. Wheatland Tube Company.
 4. or approved equal.
- B. Description: NFPA 70, Type RMC standard weight mild steel, hot dipped galvanized, sherardised or zinc-coated rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
1. Manufacturers:
 - a. Thomas & Betts Corporation.
 - b. Rayco.
 - c. Appleton.
 - d. or approved equal.

2. Connectors and Couplings: Use steel compression fittings with insulated throats.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- B. Fittings:
 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 1. Allied Tube & Conduit.
 2. Republic Conduit.
 3. Wheatland Tube Company.
 4. or approved equal.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- D. PVC-Coated Fittings:
 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
 3. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.

2.06 FLEXIBLE METAL CONDUIT AND LIQUIDTIGHT FLEXIBLE METAL CONDUIT (FMC LFMC)

- A. Manufacturers:
 1. Allied Tube & Conduit.
 2. Republic Conduit.
 3. Wheatland Tube Company.
 4. or approved equal.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- D. Spiral strip construction shall allow the conduit to bend up to four times its internal radius.
- E. Fittings shall be compression type with insulated throats and listed for use with conduit specified.

2.07 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 1. Allied Tube & Conduit.
 2. Republic Conduit.
 3. Wheatland Tube Company.
 4. or approved equal.
- B. Description: NFPA 70, Type EMT cold-rolled steel electrical metallic tubing with zinc coating on the inside and protected on the inside by a zinc, enamel or equivalent corrosion-resistant coating complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use hexagonal compression (gland) type.

- a. Do not use indenter type connectors and couplings.
- b. Do not use set-screw type connectors and couplings.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 - 1. Allied Tube & Conduit.
 - 2. Republic Conduit.
 - 3. Wheatland Tube Company.
 - 4. or approved equal.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 or Schedule 80 as indicated; rated for use with conductors rated 90 degrees C.
- C. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.09 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner tight against walls, columns or ceilings.
- C. The conduit shall bend cold 90 degrees about a radius equal to ten (10) times its own diameter without signs of flaw or fracture in either pipe or protective coverings. All bends and offsets shall be made on a forming tool to prevent the conduit or its coating from being damaged in the bending.
- D. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- E. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- H. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. Conceal all conduits unless specifically indicated to be exposed.
 - 3. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - 4. Arrange conduit to maintain maximum headroom, clearances, and access.

5. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
6. Arrange conduit to provide no more than 100 feet between pull points.
7. In every instance, conduit shall be installed in such a manner that the conductors may readily and easily be drawn or pulled in without strain or damage to the insulation; and, also, so that defective conductors may be readily and easily withdrawn and replaced by new conductors.
Long radius bends and a sufficient number of approved pull and junction boxes shall be approved for this purpose, and as may be directed by the Engineer. All conduit shall be securely supported and grounded.
8. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
9. Where conduits join any couplings or threaded fittings, the ends shall be made watertight.
10. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - I. Conduit Support:
 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 2. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 4. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 5. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 6. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 7. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 8. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
 9. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
 10. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - a. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
 - b. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
 - J. Connections and Terminations:
 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 5. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.

6. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
 7. Condulet fittings shall not be used in lieu of pull boxes.
- K. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 - a. All raceway penetrating exterior walls or other water proof membranes shall slope away from the building with a minimum slope of 4" over 100 feet.
 4. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as required to preserve integrity of roofing system and maintain roof warranty.
 5. Install firestopping to preserve fire resistance rating of partitions and other elements. Refer to penetration details on plans.
 6. Where conduits cross building expansion joints or pass between areas with a temperature difference of 14 degrees C, provide expansion fittings on all raceway.
- L. Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 2. Provide underground warning tape six to eight inches below finished grade directly above raceway. Tape shall be six inches wide with a minimum thickness of seven mil, non-distorting, colorfast, no-stretch, 600 pound tensile strength per six inch width, ultraviolet light fast. Message must repeat within a maximum of 40 inches. Painted legend shall be indicative of the type of underground line.
- M. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.
- N. Ductbanks containing conductors of 600 volts or more shall be concrete encased with red dyed concrete.
- O. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where conduits are subject to earth movement by settlement or frost.
- P. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
 3. Where conduits penetrate coolers or freezers.
- Q. Provide 200 pound tensile strength pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end. All empty conduits shall terminate in a junction box.
- R. All ducts shall be sealed at terminations, using sealing compound and plugs, as required to withstand 15 psi minimum hydrostatic pressure.

3.03 FIELD QUALITY CONTROL

- A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 05 33.13

SECTION 26 05 33.16 BOXES AND CABINETS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Floor boxes.

1.02 REFERENCE STANDARDS

- A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
 - 4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
 - 5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
 - 6. Coordinate the work with other trades to preserve insulation integrity.
 - 7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
 - 8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes, junction and pull boxes, cabinets and enclosures, and floor boxes.
- B. Project Record Documents: Record actual locations for outlet and device boxes, cabinets and enclosures, and floor boxes.

1.05 QUALITY ASSURANCE

- A. Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 - 1. The Electrical Contractor shall provide junction boxes, pull boxes, cable, support boxes, and wiring troughs as required by NEC and as otherwise indicated in the Drawings.
 - 2. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.

3. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 4. Provide products listed, classified, and labeled as suitable for the purpose intended.
 5. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 6. Provide grounding terminals within boxes where equipment grounding conductors terminate.
 7. Each outlet designated on the plans shall be provided with an outlet box.
 8. In general, outlets shall be installed at the heights indicated. The Contractor shall examine the plans of and coordinate with all other trades to assure mounting heights are correct for the intended purpose. Assure that all mounting heights comply with the latest version of ADA. Outlets installed at incorrect heights shall be relocated to the correct elevation at the Contractor's expense.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Outlet boxes shall be 4" square, 2 1/8" deep unless otherwise noted.
 4. Use suitable concrete type boxes where flush-mounted in concrete.
 5. Use suitable masonry type boxes where flush-mounted in masonry walls.
 6. Do not use "through-wall" boxes designed for access from both sides of wall.
 7. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 8. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 9. Junction boxes larger than 4" square shall be galvanized and without pre-formed knockouts.
 10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
 12. Manufacturers Recessed:
 - a. Steel City Electric Company
 - b. Metropolitan
 - c. B & C
 - d. or approved equal.
 13. Manufacturers Surface:
 - a. Crouse-Hinds
 - b. Appleton
 - c. Rayco
 - d. or approved equal.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 12" square and Larger: Provide hinged-cover enclosures with quick access latches.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 5. Manufacturers Surface:
 - a. Cooper.
 - b. Hoffman.
 - c. Hubbell Incorporated.
 - d. or approved equal..

D. Floor Boxes:

1. Description: Floor boxes compatible with floor box service fittings provided; with partitions to separate multiple services; furnished with all components, adapters, covers, faceplates, and trims required for complete installation. Number of gangs as identified on plans.
2. Cover and finish options shall be selected by architect prior to ordering.
3. Use cast iron floor boxes within slab on grade.
 - a. Protect moisture barrier during floor box installation.
4. Use sheet-steel floor boxes or fire rated poke throughs within slab above grade.
5. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
6. Manufacturer:
 - a. Legrand Wiremold
 - b. Hubbell Incorporated
 - c. Thomas & Betts Corporation
 - d. or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in a neat and workmanlike manner.
- C. Arrange equipment to provide maximum clearances.
- D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- F. Box Locations:
 1. Locate boxes in accessible locations.
 2. Locate boxes so that wall plates do not span different building finishes.
 3. Locate boxes so that wall plates do not cross masonry joints.
 4. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 5. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 6. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
- G. Box Supports:
 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
- H. Install boxes plumb and level.
- I. Flush-Mounted Boxes:
 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

- J. Install boxes as required to preserve insulation integrity.
- K. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.
- L. Boxes in damp or wet locations shall be provided with gaskets and covers.
- M. Install permanent barrier between ganged wiring devices when voltage difference between adjacent devices exceeds 300 V.
- N. Close unused box openings.
- O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

3.03 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26 05 33.16

**SECTION 26 05 33.23
SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS**

PART 2 PRODUCTS

1.01 RACEWAY REQUIREMENTS

- A. Provide all components, fittings, supports, and accessories required for a complete raceway system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

END OF SECTION 26 05 33.23

**SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Underground warning tape.
- E. Warning signs and labels.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.03 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- B. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

1.04 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location.
 - 4) Use identification nameplate to identify main overcurrent protective device.
 - 5) Use identification nameplate to identify load(s) served for each branch device where not identified in a panelboard schedule.
 - b. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location.
 - 4) Use typewritten circuit directory to identify load(s) served.
 - c. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source and circuit number. Include location.
 - 4) Identify load(s) served. Include location.
 - d. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.

- 2) Identify power source and circuit number. Include location.
 - 3) Identify load(s) served. Include location.
 - e. Enclosed Contactors:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify coil voltage.
 - 4) Identify load(s) and associated circuits controlled. Include location.
 - f. Transfer Switches:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number for both normal power source and standby power source. Include location.
 - 3) Identify load(s) served. Include location.
 - 4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
 2. Service Equipment:
 - a. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
 3. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
 5. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
 - a. Service equipment.
- B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 2. Identification for Communications Conductors and Cables: Comply with Section 27 10 00.
 3. Use underground warning tape to identify power and communication feeders and branch circuits exterior to the building.
- C. Identification for Cable Tray: Comply with Section 26 05 36.
- D. Identification for Boxes:
1. Use color coded boxes to identify specified systems.
 - a. Color-Coded Boxes: Field-painted per the same color coding as identified in this section for the system contained within.
 - b. Fire alarm junction boxes shall be painted on all sides including the box cover.
 2. For boxes concealed above accessible ceilings or exposed in mechanical or electrical rooms use neatly handwritten text using indelible marker to identify circuits enclosed.
 3. For exposed boxes in public areas, use only type written labels.
- E. Identification for Devices:
1. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
 2. Use identification label to identify fire alarm system devices.
 3. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
 4. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.
- F. Color Coding
1. Phenolic Nameplates and associated conduit and boxes shall be identified with the following color scheme. Note: For existing buildings the contractor shall field verify the existing building standard and revise the color scheme to match the existing field conditions. Failure to match

existing conditions will result in the contractor correcting the mislabeled equipment at his expense.

- a. Blue surface white core - 120/208V equipment.
- b. Black surface white core - 277/480V equipment.
- c. Bright red surface white core - fire alarm equipment.
- d. Dark red (burgundy) surface white core - security equipment.
- e. Green surface white core - emergency systems.
- f. Orange surface white core - telephone systems.
- g. Brown surface white core - data systems.
- h. White surface black core - paging systems.
- i. Purple surface white core - TV systems.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
3. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
4. Nameplates shall be secured with self tapping stainless steel screws; if screws have sharp ends they shall be protected, otherwise rivets shall be used.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.
2. Text: All capitalized unless otherwise indicated.
3. Minimum Text Height:
 - a. Equipment Designation: 1/2 inch.
 - b. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.

D. Wiring device circuit labels.

1. All wiring devices (receptacles and switches) shall be labeled with the circuit serving the device. Label shall be a typed adhesive label affixed to the front of the wiring device face plate. Label shall have black text on clear background.

2.03 UNDERGROUND WARNING TAPE

- A. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 7 mil, unless otherwise required for proper detection.
- B. Legend: Type of service, continuously repeated over full length of tape.
- C. Color:
 1. Tape for Buried Power Lines: Black text on red background.
 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.04 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.

- b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
- 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
- C. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at six to eight inches below finished grade.
- G. Secure rigid signs using stainless steel screws.
- H. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 26 05 53

**SECTION 26 05 83
WIRING CONNECTIONS**

PART 2 PRODUCTS

1.01 EQUIPMENT CONNECTIONS

END OF SECTION 26 05 83

SECTION 26 27 26 WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates.
- E. Floor box service fittings.
- F. Poke-through assemblies.

1.02 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 20 - General-Use Snap Switches Current Edition, Including All Revisions.
- C. UL 498 - Attachment Plugs and Receptacles Current Edition, Including All Revisions.
- D. UL 514D - Cover Plates for Flush-Mounted Wiring Devices Current Edition, Including All Revisions.
- E. UL 1472 - Solid-State Dimming Controls Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
 - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
 - 6. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install wiring devices until final surface finishes and painting are complete.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
 - 1. Wall Dimmers: Include derating information for ganged multiple devices.
- B. Certificates for Surge Protection Receptacles: Manufacturer's documentation of listing for compliance with UL 1449.
- C. Field Quality Control Test Reports.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Operation and Maintenance Data:
 - 1. Wall Dimmers: Include information on operation and setting of presets.
 - 2. GFCI Receptacles: Include information on status indicators.
- F. Project Record Documents: Record actual installed locations of wiring devices.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
2. Extra Keys for Locking Switches: Two of each type.
3. Extra Wall Plates: Two of each style, size, and finish.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.
- D. Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide GFCI protection for receptacles installed within 6 feet of sinks.
- E. Provide GFCI protection for receptacles installed in kitchens.
- F. Provide GFCI protection for receptacles serving electric drinking fountains.
- G. Unless noted otherwise, do not use combination switch/receptacle devices.
- H. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.02 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: White with stainless steel wall plate.
- C. Wiring Devices Installed in Finished Spaces: White with stainless steel wall plate.
- D. Wiring Devices Installed in Unfinished Spaces: White with galvanized steel wall plate.
- E. Wiring Devices Connected to Emergency Power: Red with stainless steel wall plate.

2.03 WALL SWITCHES

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell.com/#sle.
 2. Leviton Manufacturing Company, Inc.
 3. Pass & Seymour, a brand of Legrand North America, Inc
 4. Approved Equal.
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20; types as indicated on the drawings.
 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial heavy duty grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, three way, or four way as indicated on the drawings.

2.04 WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton Manufacturing Company, Inc.
 - 2. Lutron Electronics Company, Inc.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc
 - 4. Or approved equal.
- B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- C. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.
- D. Contractor shall ensure dimmer switch compatibility with luminaire controlled prior to ordering.

2.05 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc.
 - 4. Approved equal.
 - 5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498 and where applicable FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
 - 1. Standard Convenience Receptacles: Industrial Heavy Duty Grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
 - 1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 - 2. Standard GFCI Receptacles: Extra Heavy Duty Grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 - 3. Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

2.06 WALL PLATES

- A. Manufacturers:
 - 1. Hubbell Incorporated.
 - 2. Leviton Manufacturing Company, Inc.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc.
 - 4. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 2. Size: Semi-Jumbo; Midi Size.
 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
- E. Weatherproof Covers for Wet and Damp Locations: Gasketed, thermoplastic, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed. Covers must be weatherproof while in use.

2.07 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers:
1. Hubbell Incorporated: www.hubbell.com/#sle.
 2. Thomas & Betts Corporation.
 3. Wiremold, a brand of Legrand North America, Inc.
 4. Or approved equal.
- B. Description: Service fittings compatible with floor boxes provided under Section 26 05 33.16 with components, adapters, and trims required for complete installation.
- C. Flush Floor Service Fittings:
1. Dual Service Flush Combination Outlets:
 - a. Cover: Round - Finish to be selected by Architect.
 - b. Configuration:
 - 1) Power: Two standard convenience duplex receptacles.
 - 2) Communications: As indicated on drawings.
 - 3) Voice and Data Jacks: As indicated on the drawings.
 2. Accessories:
 - a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
 - b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

2.08 POKE-THROUGH ASSEMBLIES

- A. Manufacturers:
1. Hubbell Incorporated: www.hubbell.com/#sle.
 2. Thomas & Betts Corporation.
 3. Wiremold, a brand of Legrand North America, Inc.
 4. Or approved equal.
- B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.
- C. Flush Floor Service Fittings:
1. Dual Service Flush Combination Outlets:
 - a. Cover: Round - Finish to be selected by Architect.
 - b. Configuration:
 - 1) Power: Two standard convenience duplex receptacles.
 - 2) Communications: As indicated on drawings.
 - 3) Voice and Data Jacks: As indicated on the drawings.
 2. Accessories:
 - a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that core drilled holes for poke-through assemblies are in proper locations.
- H. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in a neat and workmanlike manner.
- B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
 - 1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - 2. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 - 3. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install wall switches with OFF position down.
- K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Where receptacles are indicated to be mounted above counters they shall be mounted horizontally.
- O. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings.

- P. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- Q. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.04 FIELD QUALITY CONTROL

- A. Inspect each wiring device for damage and defects.
- B. Operate each wall switch and wall dimmer with circuit energized to verify proper operation.
- C. Test each receptacle to verify operation and proper polarity.
- D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- E. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 26 27 26

SECTION 26 28 13 FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fuses.
- B. Spare fuse cabinet.

1.02 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses Current Edition, Including All Revisions.
- C. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses Current Edition, Including All Revisions.
- D. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses Current Edition, Including All Revisions.
- E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses Current Edition, Including All Revisions.
- F. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
 - 1. Spare Fuse Cabinet: Include dimensions.
- B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Fuses: One set(s) of three for each type and size installed.
 - 3. Fuse Pullers: One set(s) compatible with each type and size installed.
 - 4. Spare Fuse Cabinet Keys: Two.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation.
- B. Littelfuse, Inc.
- C. Mersen.
- D. Approved equal.

2.02 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- H. Provide the following accessories where indicated or where required to complete installation:
 - 1. Fuseholders: Compatible with indicated fuses.

2.03 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.
- B. Cabinet shall be located in the main electrical room unless otherwise indicated by owner.
- C. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet where indicated.
- D. Identify spare fuse cabinet in accordance with Section 26 05 53.

END OF SECTION 26 28 13

**SECTION 26 28 16.13
ENCLOSED CIRCUIT BREAKERS**

PART 2 PRODUCTS

1.01 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- D. Short Circuit Current Rating:
- E. Conductor Terminations: Suitable for use with the conductors to be installed.
- F. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- G. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
- H. Provide externally operable handle with means for locking in the OFF position.

1.02 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:
 - 1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- C. Conductor Terminations:
 - 1. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- D. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

END OF SECTION 26 28 16.13

SECTION 26 28 16.16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed safety switches.
- B. Enclosed circuit breakers.

1.02 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include wiring diagrams showing all factory and field connections.
 - 2. Contractor shall confirm that all lug sizes and quantities submitted are compatible with the conductors specified on the contract documents. Changes required to lug sizes and quantities due to lack of coordination between the contractor and the supplier are to be made at the contractor's expense.
 - 3. It is the contractor's responsibility to ensure that the equipment submitted to comply with the requirements of this section are in compliance with the requirements and recommendations of the power system studies. Any changes recommended by the power system study shall be incorporated at no expense to the project.
- C. Field Quality Control Test Reports.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Project Record Documents: Record actual locations of enclosed switches or circuit breakers.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

- C. Product Listing Organization Qualifications: Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label Electrical and Mechanical Equipment.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB/GE; _____: www.geindustrial.com/#sle.
- B. Eaton Corporation.
- C. Schneider Electric; Square D Products.
- D. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. All switches shall be heavy duty type.
- D. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- E. Horsepower Rating: Suitable for connected load.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Auxiliary Contacts: Suitable for 120v rated control circuit. Contractor is to provide auxiliary contacts in any disconnecting means that is downstream from a frequency drive. aux contacts shall be mechanically tied to switching mechanisms and shall provide both a N.O. and N.C. contacts. verify with DIV 23 prior to ordering equipment.
- H. Short Circuit Current Rating:
 - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. When a power system study is included in the contract, confirm the short circuit current rating of all devices with the results of the study prior to submitting for approval.
- I. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- J. Provide with switch blade contact position that is visible when the cover is open.
- K. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
 - 1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- L. Conductor Terminations: Suitable for use with the conductors to be installed.

- M. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- N. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- O. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: As indicated on the drawings.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- P. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- Q. Heavy Duty Switches:
 - 1. Comply with NEMA KS 1.
 - 2. Conductor Terminations:
 - a. Provide mechanical lugs for switch ratings less than 400 amperes.
 - b. Provide compression lugs for switch ratings 400 amperes and above.
 - c. Lug Material: Copper, suitable for terminating copper conductors only.
 - 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

2.03 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- D. Short Circuit Current Rating:
 - 1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
- E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- F. Auxiliary Contacts: Suitable for 120v rated control circuit. Contractor is to provide auxiliary contacts in any disconnecting means that is downstream from a frequency drive. aux contacts shall be mechanically tied to switching mechanisms and shall provide both a N.O. and N.C. contacts. verify with DIV 23 prior to ordering equipment.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 250 amperes.
- I. Provide electronic trip circuit breakers for circuit breaker frame sizes 250 amperes and above.
- J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- K. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- L. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: As indicated on the drawings.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
 - 3. Provide surface-mounted enclosures unless otherwise indicated.
- M. Provide externally operable handle with means for locking in the OFF position.
- N. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
- O. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- P. MOLDED CASE CIRCUIT BREAKERS
 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated. Series rating is not allowed.
 3. Conductor Terminations:
 - a. Provide mechanical lugs for circuit breaker frame sizes less than 400 amperes.
 - b. Provide compression lugs for circuit breaker frame sizes 400 amperes and above.
 - c. Lug Material: Copper, suitable for terminating copper conductors only.
 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 100 amperes and larger.
 5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following individually field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by setting dial.
 - 2) Long time delay.
 - 3) Short time pickup and delay.
 - 4) Instantaneous pickup.
 - 5) Ground fault pickup and delay where ground fault protection is indicated.
 6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install enclosed switches securely, in a neat and workmanlike manner.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install enclosed switches and breakers plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.

- H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Set field-adjustable circuit breaker tripping function settings as directed.
- J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K. Identify enclosed switches and breakers in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1 for breakers larger than 600A.
 - 1. Verify equipment nameplate is in accordance with contract documents.
 - 2. Inspect physical and mechanical condition.
 - 3. Inspect anchorage and alignment.
 - 4. Verify unit is clean.
 - 5. Operate breaker to ensure smooth operation.
 - 6. Perform breaker adjustments in accordance with the power system study.
 - 7. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
 - 8. Perform insulation-resistance test for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed.
 - 9. Perform contact/pole resistance test.
 - 10. Determine long-time and short time pickup and delay settings by primary current injection.
 - 11. Determine ground fault pickup and time delay by primary current injection.
- B. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 28 16.16

SECTION 26 29 23
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 2 PRODUCTS

1.01 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.
- C. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.
- D. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 1 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
 - 1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 1 design letter or inverter duty rating for induction motors.
 - 2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
 - 3. Motor nameplate data.
 - 4. Requirements for speed control range, speed regulation, and braking.
 - 5. Motor suitability for bypass starting method, where applicable.
- E. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.
- F. Operating Requirements:
 - 1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
 - 2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
 - 3. Efficiency: Minimum of 96 percent at full speed and load.
 - 4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
 - 5. Overload Rating:
 - a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
 - b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.
- G. Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
 - 1. Rectifier/Converter: Diode-based, 6-pulse type unless otherwise indicated.
- H. Control System:
 - 1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
 - 2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
 - 3. Control Functions:
 - a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
 - 1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
 - 2) Vector Control: Provide selectable autotuning function.
 - b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
 - c. Selectable braking control; DC injection or flux braking.
 - d. Adjustable minimum/maximum speed limits.
 - e. Adjustable pulse width modulation switching carrier frequency.

- f. Adjustable motor slip compensation.
 - g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
 - 4. Status Indications:
 - a. Motor run/stop status.
 - b. Motor forward/reverse status.
 - c. Local/remote control status.
 - d. Output voltage.
 - e. Output current.
 - f. Output frequency.
 - g. DC bus voltage.
 - h. Motor speed.
 - 5. Protective Functions/Alarm Indications:
 - a. Overcurrent.
 - b. Motor overload.
 - c. Undervoltage.
 - d. Overvoltage.
 - e. Controller overtemperature.
 - f. Input/output phase loss.
 - g. Output short circuit protection.
 - h. Output ground fault protection.
 - 6. Inputs:
 - a. Digital Input(s): Three.
 - b. Analog Input(s): Two.
 - 7. Outputs:
 - 8. Features:
 - a. Password-protected security access.
 - b. Event log.
- I. Power Conditioning/Filtering:
 - 1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
 - 2. Reactor Impedance: 3 percent, unless otherwise indicated or required.
- J. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
 - 1. Disconnects: Circuit breaker or disconnect switch type.
 - a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
 - b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
 - c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
 - 2. Provide door-mounted remote operator interface.
- K. Service Conditions:
 - 1. Provide controllers and associated components suitable for operation under following service conditions without derating:
 - a. Altitude: Less than 3,300 feet.
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
 - 2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.
- L. Short Circuit Current Rating:
 - 1. Provide line/input reactors where specified by manufacturer for required short circuit current rating.
- M. Conductor Terminations: Suitable for use with conductors to be installed.

N. Enclosures:

1. Comply with NEMA ICS 6.
2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
3. Finish: Manufacturer's standard unless otherwise indicated.
4. Cooling: Forced air or natural convection as determined by manufacturer.

1.02 OVERCURRENT PROTECTIVE DEVICES

END OF SECTION 26 29 23