I N F O R M A L C O N T R A C T

FOR

Cape Fear Community College
North Campus- Building NE
Labs Upfit

SCOPE OF WORK:

Provide labor, material and equipment for Building NE Lab Upfits as indicated on Plan Sheets G000, G101, G102, A101, A102, A111, A121 dated June 16, 2020 by S3 Architects; Sheets H001, H111, H121, H201, E001, E011, E021, E111, E112, E121, E122, E301, E401, E501, E502, and E601 by Stanford White, dated June 16, 2020, Project manual dated June 5, 20202 and herein. Scope includes demolition, insulation, doors/frames/hardware, light gauge framing, gypsum wallboard, painting, vinyl base, window treatments, HVAC and Electrical work.

NOTICE TO BIDDERS

Sealed proposals for this work will be received by:

David Kanoy, Executive Director of Capital Projects and Faciliites
Cape Fear Community College
Union Station Building, 502 N. Front Street, Room 174
411 N. Front Street, Wilmington, NC 28401
910-338-6792

up to **3pm on Thursday, July 30, 2020** and immediately thereafter publicly opened and read aloud. Complete plans and specification and contract documents can be obtained from:

Cape Fear Community College
Capital Projects Management
502 N. Front Street, Wilmington, NC 28401
ATTN: Barbara Evans, 910-362-7838, bevans@cfcc.edu

Contractors are hereby notified that they must have proper license under the State laws governing their respective trades and that North Carolina General Statute 87 will be observed in receiving and awarding contracts. General Contractors must have general license classification General Contracting.

A bid bond, performance bond, and payment bond are not required.

No bid may be withdrawn after the opening of bids for a period of 30 days. The Owner reserves the right to reject any or all bids and waive informalities. Proposals shall be made only on the form provided herein with all blank spaces for bids properly filled in and all signatures properly executed.

Please note on the envelope – **Bid Proposal: Attn: David Kanoy**
North Campus – NE Building
Lab Upfit Bid
Contractor License Number

A mandatory Pre-bid Conference will be held on **July 16, 2020** at **10 AM** in the lobby of Building NE, 4836 Sidbury Road, Castle Hayne, NC. Contractors intending to submit a bid for this project **must** attend the Pre-bid Conference.

GENERAL CONDITIONS

GENERAL

It is understood and agreed that by submitting a bid that the Contractor has examined these contract documents, drawings and specifications and has visited the site of the work, and has satisfied himself relative to the work to be performed.

MATERIALS, EQUIPMENT AND EMPLOYEES

The Contractor shall, unless otherwise specified, supply and pay for all labor, transportation, materials, tools, apparatus, lights, power, fuel, sanitary facilities and incidentals necessary for the completion of his work, and shall install, maintain and remove all equipment of the construction, other utensils or things, and be responsible for the safe, proper and lawful construction, maintenance and use of same, and shall construct in the best and most workmanlike manner, a complete job and everything incidental thereto, as shown on the plans, stated in the specifications, or reasonably implied there from, all in accordance with the contract documents.

All materials shall be new and of quality specified, except where reclaimed material is authorized herein and approved for use. Workmanship shall at all times be of a grade accepted as the best practice of the particular trade involved, and as stipulated in written standards of recognized organizations or institutes of the respective trades except as exceeded or qualified by the specifications.

No changes shall be made in the work except upon written approval and change order of the Owner. Change orders shall be subject to provisions in the current North Carolina Construction Manual.

Products are generally specified by ASTM or other reference standard and/or by manufacturer's name and model number or trade name. When specified only by reference standard, the Contractor may select any product meeting this standard, by any manufacturer. When several products or manufacturers are specified as being equally acceptable, the Contractor has the option of using any product and manufacturer combination listed.

However, the Contractor shall be aware that the cited examples are used only to denote the quality standard of product desired and that they do not restrict bidders to a specific brand, make, manufacturer or specific name; that they are used only to set forth and convey to bidders the general style, type, character and quality of product desired; and that equivalent products will be acceptable. Substitution of materials, items or equipment of equal or equivalent design shall be submitted to the Owner for approval or disapproval; such approval or disapproval shall be made by the Owner prior to the opening of bids.

If at any time during the construction and completion of the work covered by these contract documents, the conduct of any workman of the various crafts be adjudged a nuisance to the Owner or if any workman be considered detrimental to the work, the Contractor shall order such parties removed immediately from the site.

The contractor shall designate a foreman/superintendent who shall direct the work.

CODES, PERMITS AND INSPECTIONS

The Contractor shall obtain the required permits, if required, give all notices, and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of the work under this contract. If the Contractor observes that the drawings and specifications are at variance therewith, he shall promptly notify the Owner in writing. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, codes, rules and regulations, and without such notice to the Owner, he shall bear all cost arising there from. Projects constructed by Cape Fear Community College are subject to county or municipal building codes and inspection by the authority(s) having jurisdiction. The Contractor shall obtain building permits at no cost to the Owner.

SAFETY REQUIREMENTS

The Contractor shall be responsible for the entire site and the construction of the same and provide all the necessary protections as required by laws or ordinances governing such conditions and as required by the Owner. He shall be responsible for any damage to the Owner's property, or that of others on the job, by himself, his personnel or his subcontractors, and shall make good such damages. He shall be responsible for and pay for any claims against the Owner arising from such damages.

The Contractor shall adhere to the rules, regulations and interpretations of the North Carolina Department of Labor relating to Occupational Safety and Health Standards for the Construction Industry (Title 29, Code of Federal Regulations, Part 1926 published in Volume 39, Number 122, Part 11, June 24, 1974 Federal Register), and revisions thereto as adopted by General Statutes of North Carolina 95-126 through 155.

The Contractor shall provide all necessary safety measures for the protection of all persons on the work, including the requirements of the AGC Accident Prevention Manual in Construction as amended, and shall fully comply with all state laws or regulations and North Carolina Building Code requirements to prevent accident or injury to persons on or about the location of the work. He shall clearly mark or post signs warning of hazards existing, and shall barricade excavations and similar hazards. He shall protect against damage or injury resulting from falling materials and he shall maintain all protective devices and signs throughout the progress of the work.

TAXES

North Carolina Sales Taxes and Use Tax do apply to materials entering incorporated into this work (N.C. Sales and Use Tax Regulation No. 42, Paragraph A), and such costs shall be included in the bid proposal and contract sum.

Local Option Sales and Use Taxes do apply to materials incorporated into this work as applicable (Local Option Sales and Use Tax Act, Regulation No. 57), and such cost shall be included in the bid proposal and contract sum.

EQUAL OPPORTUNITY

The non-discrimination clause contained in Section 202 (Federal) Executive Order 11246, as amended by Executive Order 11375, relative to Equal Employment Opportunity for all persons without regard to race, color, religion, sex or national origin, and the implementing rules and regulations prescribed by the Secretary of Labor, are incorporated herein.

The Contractors agree not to discriminate against any employees or applicant for employment because of physical or mental handicap in regard to any position for which the employees or applicant is qualified. The Contractor agrees to take affirmative action to employ, advance in employment and otherwise treat qualified handicapped individuals without discrimination based upon their physical or mental handicap in all employment practices.

INSURANCE - ***Please see attachment - CFCC Insurance Requirements***

The Contractor shall not commence work until he has obtained all insurance required, and the Owner has approved such insurance, nor shall the Contractor allow any subcontractor to commence work on his subcontract until all similar insurance required of the subcontractor has been obtained.

The Contractor shall provide and maintain during the life of this contract Workmen’s Compensation Insurance for all employees employed at the site of the project under his contract.

The Contractor shall provide and maintain during the life of this contract such Public Liability and Property Damage Insurance as shall protect him and any subcontractor performing work covered by this contract, from claims for damage for personal injury, including accidental death, as well as from claims for property damages which may arise from operations under this contract, whether such operation be by the

Contractor himself or by any subcontractor, or by anyone directly or indirectly employed by either of them and the amounts of such insurance shall be as follows:

Public Liability Insurance in an amount not less than $300,000 for injuries, including accidental death, to any one person and subject to the same limit for each person, in amount not less than $500,000 on account of one accident; and Property Damage Insurance in an amount not less that $100,000/$300,000.

The Contractor shall furnish such additional insurance as may be required by General Statutes of North Carolina, including motor vehicle insurance in amounts not less than statutory limits.

Each Certificate of Insurance shall bear the provision that the policy cannot be canceled, reduced in amount or coverage eliminated in less than fifteen (15) days after mailing written notice to the insured and/or the Owner of such alteration or cancellation, sent by registered mail.

The Contractor shall furnish the Owner with satisfactory proof of carriage of the insurance required before written approval is granted by the Owner.

INVOICES FOR PAYMENT

Partial payments will be made monthly based on percentage of work completed during the previous month. Payment for stored material may also be made upon verification by a representative of Cape Fear Community College. Final payment will be made within forty-five (45) consecutive days after acceptance of the work and the submission of the closeout documentation.

Executed contract documents, insurance certifications and, upon completion and acceptance of the work, invoices and other information requested are to be sent to: Barbara Evans, Project Coordinator ,**Cape Fear Community College,** 411 N. Front Street, Wilmington, NC 28412, Telephone: 910-362-7838. It is imperative that contract documents, invoices, etc., be sent only to the above address in order to assure proper and timely delivery and handling.

CLEANING UP

The Contractor shall keep the sites and surrounding area reasonably free from rubbish at all times and shall remove debris from the site from time to time or when directed to do so by the Owner. Before final inspection and acceptance of the project, the Contractor shall thoroughly clean the sites, and completely prepare the project and site for use by the Owner.

GUARANTEE

The Contractor shall unconditionally guarantee materials and workmanship against patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve (12) months following the final acceptance of the work and shall replace such defective materials or workmanship without cost to the Owner.

Where items of equipment or material carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material. The Contractor shall replace such defective equipment or materials, without cost to the Owner, within the manufacturer's warranty period.

Additionally, the Owner may bring an action for latent defects caused by the negligence of the Contractor, which is hidden or not readily apparent to the Owner at the time of Beneficial Occupancy or final acceptance, whichever occurred first, in accordance with applicable law.

CONTRACTOR-SUBCONTRACTOR RELATIONSHIPS

The Contractor agrees that the terms of these contract documents shall apply equally to a subcontractor as to the Contractor, and that the subcontractor is bound by those terms as an employee of the Contractor.

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 Owner and shall fully complete all work hereunder within Ninety **(90)** consecutive calendar days from the Notice to Proceed.

If the Contractor is delayed at anytime in the progress of his work by any act or negligence of the Owner, his employees or his separate subcontractor, 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.

UTILITIES

Owner will provide electrical power and water at point of source. Connections and extensions will be by the Contractor. Temporary bathroom facilities for construction work will be by the general contractor.

SECURITY

The Contractor shall be responsible for providing security for his material and equipment.

PERMITS

The Contractor shall obtain and pay for all permits and inspections required by local authorities having jurisdiction and obtain certifications of compliance regarding the satisfactory completion of the work under each jurisdiction.

NO SMOKING POLICY

Cape Fear Community College is a 100% tobacco free campus. This includes, all tobacco products and e-cigarettes.

E-PROCUREMENT

All Contractors **must** be registered with North Carolina E-procurement prior to beginning work.

INTERACTIVE PURCHASING SYSTEM

The Contractor **shall** be Registered Vendor with IPS prior to being awarded a Contract.

MINORITY BUSINESS PARTICIPATION

NC General Stature 143-128.2 established a tem per percent (10%) goal for participation by minority business in total value of work for each project. The Contractor **must include with their bid** a completed Identification of HUB Participation form **and** Affidavit A-Listing of Good Faith Efforts **or** Affidavit B-Intent to Perform with Own Workforce. These forms **must** be included with the Contractor's bid. Failure to include the required documents may result in the Owner rejecting the bid. The Contractor shall comply with the document *Guidelines* for Recruitment and Selection of Minority Businesses for Participation including Affidavits C and D. The Contractor **must** submit completed Appendix E-MBE Documentation for Contract Payments form with their **final** payment request.

JESSICA LUNSFORD STATEMENT

The Contractor shall comply with NC General Statutes: Chapter 11SC-332.1 Sex Offender registries checks, no less than annually, of its employees who provide contracted services to Cape Fear Community College. The check must include the North Carolina State Sex Offender and Public Protection Registration Program, the North Carolina State Sexually Violent Predator Registration Program and the National Sex Offender Registry. As a term of contract, Contractor will provide CFCC with a statement certifying that

none of its employees who will work at any CFCC facility are listed with these programs or registries. **This statement is required within 30 days of the execution of contract.**

CONSTRUCTION SCHEDULE AND SCHEDULE OF VALUES

The Contractor shall submit a Construction Progress Schedule and a Schedule of Values for approval by the Owner prior to commencement of work.

The Progress Schedule shall be a listing of milestone dates to the Owner. No payment will be made without an approved Progress Schedule. The scheduled items of work shall be consistent with the items indicated in the Schedule of Values.

The content of the Progress Schedule shall be coordinated with the Schedule of Values. No payment will be make without an approved Schedule of Values. The Schedule of Values shall be prepared on AIA Documents G702 and G703 indicating the items of work and associated costs for each item. The breakdown shall include labor and materials costs for each item of work. The Schedule of Values will be used as the basis of approving payments.

CONSTRUCTION FACILITIES

The Owner will provide electrical power and water during the construction process. The Contractor will provide temporary generators if needed to operate equipment that cannot operate by 120 volt electrical service.

The Contractor shall provide sufficient rubbish bins and is responsible for removal of construction debris and rubbish from the site on a daily basis.

WARRANTY

The Contractor agrees to warrant the materials and workmanship for a period of one (1) year from the date of Final acceptance of the Project by the Owner.

CLOSE-OUT PROCEDURES -

The Contractor will notify the Owner when the project is complete, including all Punch List items. Upon Final acceptance by the Owner the Contractor shall submit the documents included in the **Close-out Document Checklist.** ***Please see attachment***.

DISPUTE RESOLUTION

In the event a dispute arises between the Owner and the Contractor that cannot be resolved by mutual negotiation, both parties agree prior to arbitration and/or litigation to endeavor to settle such disputes in accordance with the Construction Industry Mediation Rules of the American Arbitration Association currently in effect. A demand for mediation shall be filed in writing with the other party of the Agreement and with the American Arbitration Association. The demand for mediation shall be made within a reasonable time after the claim, dispute or other matter in question has arisen. In no event shall the demand for mediation be made after the date when institution or legal or equitable proceedings based on such claim, dispute or other matter in question would be barred by the applicable statute of limitations.

SCHEDULE OF ALTERNATES

BASE BID

The base bid shall consist of all of the work required on the plans to complete the upfit of Lab NE131, and work shown in Mechanical room NE122, Including general conditions and all costs associated with project mobilization.

ADD ALTERNATE ONE

Add Alternate One shall consist of all the work required on the plans to complete the upfit of Lab NE135.

ADD ALTERNATE TWO

Add Alternate Two shall consist of all the work required on the plans to complete the upfit of Lab rooms NE110 and NE 112.

ADD ALTERNATE THREE

Add Alternate Three shall consist of all the work required on the plans to complete the upfit of Lab NE223.

Disregard reference to Column Enclosures as Alternates on Sheet A111, All column enclosure work shown shall be performed as part of the base bid or as part of the alternate bid for the room the enclosures are in.

PROPOSAL AND CONTRACT

for

North Campus – NE Building
Lab Upfit

The project site is located at Cape Fear Community College North Campus in Castle Hayne, NC.

We are in receipt of Addendum No(s). 1_____ 2_____ 3_____ 4_____

The undersigned, as bidder, proposes and agrees if this proposal is accepted to contract with Cape Fear Community College 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 Cape Fear Community College for the sum of:

BASE BID-Lab NE 131: _____

_____ **Dollars**

ADD ALERNATE ONE-Lab NE 135: _____

_____ **Dollars**

ADD ALERNATE TWO-Lab NE110 and NE 112: _____

_____ **Dollars**

ADD ALERNATE THREE-Lab NE 223: _____

_____ **Dollars**

submitted this _____day of_____20____

_____

(Contractor)

Federal ID#:_____ By:_____

Witness:_____ Title:_____
(O*wner, 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 CAPE FEAR COMMUNITY COLLEGE

Total amount accepted by the Owner:

_____

BY:_____TITLE: President_____
Jim Morton

DATE:_____

Minimum Insurance Requirements

Insurance Requirements	
Commercial General Liability (CGL) – (occurrence form) coverage not less than: **Schedule of Endorsements must be provided** **GL Policy Number must be listed**	$2,000,000 General Aggregate* $1,000,000 Products and Completed Operations Aggregate $1,000,000 Each Occurrence *Including contractual liability, waiver of subrogation, primary & non-contributory.
Commercial Auto Liability: – Required for all Owned Autos or must include 'Hired & Non-Owned Auto' coverage:	$1,000,000 Combined Single Limit
Umbrella Liability – Additional coverage that can be combined to meet requirements	
Workers' Compensation is required if the contractor/vendor has employees. A Waiver of Worker's Compensation is acceptable for a Sole Proprietor, Partners, or LLC that has NO employees.	State Statutory Limits* Employee Liability $500,000 Each Accident $500,000 Disease Policy Limit $500,000 Disease Each Employee ***Including waiver of subrogation in favor of CFCC**
Additional Insured – Cape Fear Community College, its officers, agents and employees are included as additional insured under contractors/vendors Commercial General Liability coverage.	– Coverage must be primary and non-contributory above any other insurance Cape Fear Community College may carry.
Additional Requirements, When Applicable	
Professional Liability (Errors and Omissions) —if professional services are being provided	$1,000,000 Per Occurrence/$2,000,000 Aggregate
Environmental/Pollution Liability — if applicable	Amount TBD; Required if use of hazardous materials or environmentally sensitive.
Garage Liability and/or Garage Keepers **On-Hook Cargo**	Amount = to value of vehicles/vessel being stored. Amount = to value of vehicles/vessel being towed.
Fidelity Bond	Amount TBD; Required if loss of money or other property is at risk due to dishonest acts.
Cyber Liability	$1,000,000 Per Occurrence *Including information security & privacy liability
Installation Floater	Amount = to value of equipment being installed; Required if job involves installation of equipment.
Bid, Performance, Payment Bonds	Amount = to 100% of construction contract amount; Required depending on the size/location/description of work.
Liquor Liability	$1,000,000 Per Occurrence if lessee sells/serves alcoholic beverages.

All Risk levels of Certificates of Insurance should include the following:

1. Cape Fear Community College, its officers, agents and employees are included as additional insured.
2. Disclose any self-insured retention (allowed only if pre-approved)
3. Designate Cape Fear Community College as certificate holder.
4. Cape Fear Community College shall be notified at least 30 days in advance of cancellation or material change in coverage.
5. Provide a Waiver of Subrogation on Worker's Compensation/Employer's Liability; contact Risk Mgmt. if not available from insurer.

CERTIFICATES OF INSURANCE MUST INDICATE THE FOLLOWING

1) CFCC needs to be listed as the **Additional Insured**:
    - Cape Fear Community College, its officers, agents and employees must be included as additional insured under contractors/vendors Commercial General Liability as it pertains to the work done/service provided and/or product delivered to the College.
    - Coverage must be primary and non-contributory above any other insurance CFCC may carry
2) CFCC needs to be listed as the Certificate Holder: **Cape Fear Community College, ATTN: Lisa Wilcox, Risk Management Specialist 411 N. Front Street, Wilmington, NC 28401**
3) CFCC requires a COI which shows General Liability, Workers' Compensation, Automobile Liability.
    a. Risk Management may opt to waive the requirements for Automobile Liability or the Workers' Compensation—depending on the scope and scale of the job or event.
4) Carrier and effective/expiration date must be shown on all coverages listed on COI.
5) If a professional advice or certification service is being rendered, a COI will need to be provided with proof of Professional Liability.
6) If a service is being rendered involving alcohol, Liquor Liability will need to be provided.
7) If the service being rendered involves waste removal of any kind, a COI will need to be provided with proof of Pollution Liability as well as Transportation Liability.
8) If a service is being rendered parking, storing or towing a vehicle/vessel, Garage Liability or Garage Keepers and/or On-Hook Cargo will need to be provided.
9) If any products and/or services related to information technology (including hardware and/or software) are provided to CFCC, Cyber Liability and Technology Errors and Omissions will be required. Additionally, network security liability arising from the unauthorized access to, use of, or tampering with computer systems, including hacker attacks or inability of an authorized third party to gain access to your services, including denial of service, unless caused by a mechanical or electrical failure.
10) **There may be instances where Risk Management will require other additional insurance and/or coverages that are based on the service(s) provided**.

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:_____

SEAL

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: _____

SEAL

State of _____, County of _____

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

Notary Public _____

My commission expires _____

Do not submit with bid Do not submit with bid Do not submit with bid Do not submit with bid

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:_____

SEAL

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 Name)

Project ID#_____ 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:

A. 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.

B. Copies of quotes or responses received from each firm responding to the solicitation.

C. A telephone log of follow-up calls to each firm sent a solicitation.

D. 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.

E. Documentation of any contacts or correspondence to minority business, community, or contractor organizations in an attempt to meet the goal.

F. Copy of pre-bid roster

G. Letter documenting efforts to provide assistance in obtaining required bonding or insurance for minority business.

H. Letter detailing reasons for rejection of minority business due to lack of qualification.

I. 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:_____

SEAL

State of _____, County of _____

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

Notary Public_____

My commission expires _____

Cape Fear Community College

CLOSE-OUT DOCUMENT CHECKLIST

Project: _____

Contractor:_____ Final Completion Date: _____

Note: When all of the following documents have been completed and received, this checklist should be completed. Copies of documents should accompany the final application for payment.

☐ 1. Fully Executed Final Change Order (i.e., for allowances, deductions for work done by others etc.).

☐ 2. Final Approved Application for Payment along with MBE Documentation for Contract Payments – Appendix E

☐ 3. Contractor's Final Affidavit and Waiver of Liens properly signed and notarized

☐ 4. Certificate of approval from County Inspections Department.

☐ 5. Contractor's One Year Warranty.

☐ 6. Warranty Summary Sheet and original Mfg. Warranties for specific items (ex: heat pumps) etc.

☐ 7. Contractor's Certification of Non-Use Asbestos

☐ 8. Record Drawings received from Contractor.

☐ 9. Operations and Maintenance Manuals

_____ _____

Project Manager's Signature Date:

CAPE FEAR COMMUNITY COLLEGE

Project Manual

Cape Fear Community College
NE Building Labs Upfit

4820 Sudbury Road
Castle Hayne, NC

Prepared for:
Cape Fear Community College

By:

S3 ARCHITECTS

Studio Three Architects
321 N Front Street
Wilmington, NC 28401
(910) 269-3024
S3architects.com

Stanford White

1620 Midtown Place
Raleigh, NC 27609
NC License C-1719
tel 919.832.8118
fax 919.832.8120
stanfordwhite.com

June 16, 2020

Project Manual
for

Cape Fear Community College
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6/16/20

and

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Raleigh, NC 27609
NC License F-1434
tel 919.832.8118
stanfordwhite.com

6.16.20

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SECTION 019913 - GENERAL REQUIREMENTS FOR DIVISIONS 23-28 WORK

The "Engineer of Record" for the work defined by Division 01 Sections 019913, 019916, 019926 is Stanford White, Inc., 1620 Midtown Place (27609), P.O. Box 19944 (27619), Raleigh, NC, (919) 832-8118. The term "engineer," "architect-engineer," "engineer-architect," "A-E," "E-A," etc., when used in these Sections shall reference Stanford White, Inc.

The "Engineer of Record" for the work defined by Divisions 23-28 is Stanford White, Inc., 1620 Midtown Place (27609), P.O. Box 19944 (27619), Raleigh, NC, (919) 832-8118. The term "engineer," "architect-engineer," "engineer-architect," "A-E," "E-A," etc., when used in Divisions 23-28 Drawings and Specifications shall reference Stanford White, Inc.

PART 1 - GENERAL

RELATED DOCUMENTS

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

The requirements specified herein shall govern all Sections in Divisions 23-28, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

REVIEW OF CONTRACT DOCUMENTS

The Contract Documents may represent imperfect data and may contain errors, omissions, conflicts, inconsistencies, code violations and improper use of materials. Such deficiencies will be corrected by the A-E when identified. The Contractor shall carefully study and compare the individual Contract Documents with each other and report at once in writing to the A-E any deficiencies the Contractor may discover. The Contractor shall require each subcontractor to likewise study the documents and report at once any deficiencies discovered. The Contractor shall resolve all reported deficiencies with the A-E prior to starting any work. **Any work performed prior to receipt of instructions from the A-E will be done at the Contractor's risk.** If the Contractor performs any construction activity knowing it involves a recognized error, inconsistency, or omission in the Contract Documents without such notice to the A-E, the Contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the attributable costs for correction.

The Contractor shall be responsible for maintaining habitable structures under this Contract rainproof, and for making equipment and utility installations properly perform the intended function. If he is prevented from so doing by any limitations of the drawings or specifications, the Contractor shall immediately notify the A-E in writing of such limitations before proceeding with construction in the area where the problem or limitation exists.

DEFINITIONS

Mechanical Work: Work required by this Contract as defined by Division 23 (Heating, Ventilating, and Air-Conditioning).

Electrical Work: Work required by this Contract as defined by specification Divisions 26-28.

Labeled: Appliances, equipment, materials or products to which has been attached a label, symbol, or other identifying mark of an organization acceptable to the North Carolina Building Code Council and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with identified standards or has been tested and found suitable for a specified purpose.

Listed: Appliances, equipment, materials or products included in a list published by an organization acceptable to the North Carolina Building Code Council and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets appropriate designated standards or has been tested and found suitable for a specified purpose.

Concealed: Work within or behind various construction elements or in crawl spaces or trenches that is not exposed to view when the project is complete.

Exposed: Not "concealed" as defined above, or anything exposed to view when the project is complete.

Wiring: Cable, raceways, fittings, mechanical supports, wire, junction boxes, device boxes, outlet boxes, switches, cutouts, and related items.

CODES, LAWS, REGULATIONS, AND STANDARDS

Work on and for the project shall conform to requirements of each applicable volume of the *North Carolina Building Code*; shall comply with the regulations of the N.C. Department of Labor, including the latest revisions and interpretations of the *Occupational Safety and Health Act of North Carolina;* and be in accordance with all other codes, laws, rules and regulations that apply to this project.

"Confined spaces" and "permit-requiring confined spaces", as defined by U.S. Occupational Safety and Health Administration (USOSHA) may exist in the work area or may be created by the construction of this Project. The Contractor shall be responsible for identification of any permit-requiring confined spaces and for establishing all required procedures for meeting the requirements of USOSHA relative to these spaces, including written confined space entry program(s).

Codes, laws, regulations, and/or industry standards referenced in the Specification or on the Drawings shall be considered to be part of the Project requirements. Applicable edition of the referenced volume is the edition that is/was in effect at the time the construction permit was issued or at the time of approval of the Contract Documents by the Authority Having Jurisdiction.

INTENT AND WORKMANSHIP

The words "furnish," "furnish and install," "install," and "provide" or words with similar meaning shall be interpreted, unless otherwise specifically stated, to mean "furnish and install complete in-place and ready for service."

The work of all trades under this Contract shall be coordinated in such a manner as to obtain the best workmanship possible.

Miscellaneous items and accessories that are not specifically shown on the drawings or specified herein, but which are essential to produce a complete and properly operating installation, or usable structure or plant, providing the indicated function, shall be furnished and installed without change in the Contract price. Such miscellaneous items and accessories shall be of the same quality standards, including material, style, finish, strength, class, weight and other applicable characteristics, as specific for the major component of which the miscellaneous item or accessory is an essential part. The above requirement, however, is not intended to include major components not covered by or inferable from the drawings and specifications.

WELDER QUALIFICATION

Where welding is required on vessels or piping with an ASME P- or S- stamp, qualify welders for welding procedures complying with ASME *Boiler and Pressure Vessel Code*, Section IX. Submit *Welder's Performance Qualification Record* required by the ASME *Boiler and Pressure Vessel Code*.

For piping and structural supports welding, qualify welders in accordance with AWS QC7 *Standard for AWS Certified Welders* for welding procedures complying with ASME B31.1 or ASME B31.9, as applicable. Submit *Welder's Performance Qualification Record* required by ASME B31.1 or B31.9 and a copy of the most recent *Maintenance of Welder Certification* form submitted to AWS.

In addition, submit each welder's assigned number, letter, or symbol used to identify the work of the welder. This symbol shall be stamped in or adjacent to each completed weld.

QUALITY ASSURANCE

The Contract Drawings indicate the extent and general arrangement of the Work. The Contractor shall coordinate the Work under his Contract so as to avoid conflicts between his work and the work of other trades. He shall carefully examine the Drawings and shall be responsible for the proper fitting of materials and equipment into the space provided. If any departures from the Contract Drawings are deemed necessary by the Contractor, detail drawings of such departures and the reasons therefore shall be submitted as soon as practicable to the A-E for his review. No such departures shall be made without this review and written clarification or change order.

If manufacturer recommended details or installation instructions differ from the contract drawings or specifications, then the contractor shall notify the A-E immediately of any discrepancies.

The Drawings and Specifications shall be considered supplementary, one to the other, so that materials and/or labor indicated, called for, or implied by one and not the other shall be provided as though specifically called for in both.

Firestop Materials Codes and Standards: Comply with ASTM Standard E814 and applicable categories of UL's current *Fire Resistance Directory*, Vol. I and II, for compliance with ANSI/UL Standard 1479.

Access Doors Fire-Resistance Ratings: Where fire-resistance rating is indicated for construction penetrated by access units, provide Listed and Labeled units.

OBSERVATION

All work shall be done by skilled technicians, continuously supervised by the Contractor and subject to observation and final acceptance by the A-E. Such final acceptance shall in no way relieve the Contractor from responsibility for defects in either workmanship or material that may subsequently develop.

SUBMITTALS

Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Material and equipment schedules, catalog cuts, manufacturers' data and shop drawings, and field working drawings as required by individual Sections shall be provided.

Shop drawings, technical data and other such submittals required by individual Sections of the Divisions listed above shall be provided.

Equipment drawings, manufacturer's installation instructions as shipped with the equipment, field working and location drawings, wiring diagrams, and coordination drawings shall be provided by the Contractor for items of equipment, sleeves, foundations, curbs, wiring, ductwork, piping, etc., as necessary for information and coordination of all trades. These drawings shall be provided sufficiently in advance of installation to avoid delays and removal and reworking of installed work, and so as to provide information to other trades when and as required. No work shall be done until these drawings have been coordinated by the Contractor.

Submittals shall be checked before submission by technically qualified employees of Contractor for accuracy, completeness and compliance with Contract requirement. **All submittals shall be accompanied by the "Submittal Cover Form" provided at the end of this Section, signed by Contractor**.

Contractor shall submit complete lists or schedules of all proposed sub-contractors and material suppliers, and of all proposed construction materials and equipment. Materials and equipment lists shall be complete with trade names and/or catalog numbers of each item. Processing of the second and subsequent Certificate for Payment will be withheld until substantial portions of these lists have been submitted.

Products furnished shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer.

Products proposed by the Contractor shall be new except where specifically noted otherwise. Contractor(s) shall provide products only from manufacturers who have published data showing compliance with specified requirements or who certify in writing to such compliance (including laboratory and/or in-place testing, if applicable). All electrical products shall be both labeled and listed, as defined above. **Prior to purchase of major materials, equipment or systems, submit manufacturer's data to the A-E for review as hereinafter specified.**

Products of the specified type and for the specified application offered by the Contractor(s) for use on this Project shall comply with the following requirements:

Product shall have had satisfactory performance in applications of similar character to that specified for a period of at least three (3) years.

Product shall be from an established national or regional manufacturer. The A-E's experience with the manufacturer on prior projects relative to product performance, technical support, etc. may be taken into account to establish suitability of the offered product for this Project.

Product shall be provided through an authorized representative of the manufacturer. The representative shall be capable of providing technical support relative to the installation, operation, and maintenance of the product. The A-E's experience with the representative on prior projects relative to product performance, technical support, etc. may be taken into account to establish suitability of the offered product for this Project.

Repair parts and service for the product shall be available within twenty-four (24) hours of notice.

The manufacturer and his authorized representative shall furnish satisfactory evidence in support of these conditions when requested. The A-E's decision relative to the suitability and acceptability of any product is final and acceptance of this limitation is implicitly acknowledged by the contractor and the manufacturer and/or his representative offering the product for use on this Project.

Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the specifications the submittal shall clearly indicate such deviations by being marked "**NON-COMPLYING FEATURE**." This indication shall be applied to the submittals at the appropriate location in a color contrasting with the remainder of the submittal. Additional information that might assist the Engineer in product evaluation may be included with the submittal. This information should indicate how a specific non-complying feature is believed by the Contractor to meet the intent of the specification.

It is the Contractor's responsibility to demonstrate compliance with the specifications and to clearly indicate any features that do not meet the specifications. It is not the Engineer's responsibility to identify non-compliance. Substantial non-compliance, as determined by the Engineer, is grounds for rejection of the submittal. Discovery of non-complying features that have not been properly identified as such on submittals may require, at any stage of construction, the removal and replacement of the non-complying item(s).

The A-E will review shop drawings, manufacturer's data, and samples with reasonable promptness. This review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with the requirements of the plans and specifications. Approval of a specific item shall not include approval of an assembly of which the item is a component. Contractor is responsible for dimensions

to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of his or her Work with that of all other trades; and for performing all work in a safe and satisfactory manner. The Contractor is responsible for any delay caused by his failure to observe submittals requirements and the time for completion of his Contract will not be extended because of such delays.

The A-E's submittals review stamp categories shall be interpreted as follows:

Reviewed: Fabrication and installation or erection may be undertaken.

Exceptions indicated, revise and proceed: Fabrication and installation of erection may be undertaken. However, Contractor shall comply with all notes or corrections indicated.

Exceptions indicated, revise and re-submit: Neither fabrication, installation, nor erection shall be undertaken. Re-submit corrected copies for review. Corrections shall be limited to items marked, except that changes required in order to coordinate the corrections indicated shall be made. All changes, other than those indicated, shall be called specifically to the A-E's attention.

Rejected, re-submit: Neither fabrication, installation, nor erection shall be undertaken. Revise entire submission to comply with information given in the Contract Documents and re-submit.

Submittals returned to the Contractor with the A-E's "reviewed" or "exceptions indicated, revise and proceed" stamp need not be resubmitted, except that corrected copies of "exceptions indicated, revise and proceed" submittals shall be furnished for record when requested.

Submittals returned to the Contractor with the A-E's "revise and re-submit" or "rejected, re-submit" stamp shall be corrected to comply with Contract requirements and re-submitted to the A-E for review. The Contractor shall direct specific attention, in writing or on re-submitted shop drawings, product data or samples, to revisions other than those requested by the A-E on previous submittals.

Shop drawings of work that involves more than one subcontractor shall be coordinated by the Contractor and submitted to A-E under one cover. No items shall be fabricated, nor any portion thereof shipped to site, prior to receipt by the Contractor of all applicable submittals, including manufacturer's data, samples and shop drawings bearing the A-E's "reviewed" or "exceptions indicated" stamp only.

Manufacturer's data submitted as required by the technical specifications sections or requested by A-E shall consist of four (4) copies of certificates, schedules, catalog cuts, manufacturer's specifications and installation instructions for each type of product or material. Include maintenance recommendations, fire ratings and other reports when applicable to show compliance with the Specifications. When catalog cuts are submitted, the specific item to be considered shall be identified. Items that are not so identified will be returned to the Contractor without action.

Firestop Systems: Submit data on products. Provide manufacturer's certification of UL classification(s) required, including copies of UL systems listings and schedule defining each UL system proposed and the applicable type of penetration.

Access Units: Submit manufacturer's technical data and installation instructions for each type of access door assembly, including setting drawings, templates, instructions and directions for installation of anchorage devices.

Contractor shall submit for review any samples required by the technical specification sections or that may be requested by the A-E.

With each electrical testing and compliance submittal, Contractor shall submit evidence of compliance that each manufactured item or component of electrically-operated equipment and that each fabricated assembly of electrically operated equipment furnished complies with the testing requirements.

FIRE RATINGS

Fire rating of walls and floors, as indicated on the Drawings, are for reference only. Refer to Architectural Drawings for exact construction and fire ratings.

Where fire resistive insulation or other coverings have been applied to a structural element to obtain a fire rating and this insulation or covering is removed or otherwise disturbed, the Contractor shall be responsible for restoring the material to a condition that matches the original fire protective ability.

USE OF BRAND NAMES

Brand names, where scheduled as “basis of design,” are to be considered for information purposes and are not intended to be a product specification.

Where the Contractor proposes to use an item of equipment other than that indicated as basis of design that may require redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required shall be prepared by the Contractor at his own expense and submitted for review by the A-E.

Where such deviation requires a different quantity and arrangement of ductwork, piping, wiring, raceway, or equipment from that specified or indicated on the Drawings, the Contractor shall furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and raceway, and any other additional equipment required by the system, at no additional cost.

Brand names, where used as a product specification, are intended to denote the standard of quality required for the particular material or product.

Where the term “equal” or “equivalent” is present, such specification does not restrict the Contractor to a specific brand and equivalent products by other manufacturers may be acceptable. The term "equal" or "equivalent" shall be interpreted to mean a material or product that is similar and equal in type, quality, size, capacity, composition, finish, color, and other performance characteristics to the material or product specified by brand name, and that, **in the opinion of the A-E**, is suitable for the same use and capable of performing the same function as the material or product specified. **Proposed equivalent items must be reviewed by the A-E before they are purchased or incorporated into the work**.

EQUIPMENT SUBSTITUTIONS AND CHANGES/EXTRA COSTS FOR CHANGES IN BUILDING SERVICES

Where the Contractor proposes to use an item of equipment other than that specified or detailed on the Drawings, requiring any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required shall be prepared by the Contractor at his own expense and submitted for review by the A-E.

Where such approved deviation requires a different quantity and arrangement of ductwork, piping, wiring, raceway, or equipment from that specified or indicated on the Drawings, the Contractor shall furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and raceway, and any other additional equipment required by the system, at no additional cost.

It is the responsibility of the Contractor to notify the A-E in all cases where the requirements of proposed equipment differ from the requirements specified, shown, or implied on the Drawings or within the Specifications. **Failure of the Contractor to notify the A-E shall not relieve the Contractor of the responsibility of providing compatible equipment at no additional cost as described above**.

OPERATION AND MAINTENANCE DATA

For each Division of the Work, provide four (4) copies of Operating Manuals, Maintenance Manuals, and Test Reports, bound in suitable covers, to the A-E at least two (2) weeks **prior** to the final inspection of the project.

Each manual shall include a cover sheet listing the following:

Project name and location.

Division of Work covered by the manual.
Contractor data, including name, address, phone and fax numbers, and service contact information (24-hour number, email address, etc.)

Date of project completion.

Each manual shall include a table of contents.

Operating manual: Provide all relevant information needed for day-to-day operation and management of the building systems. Include the following for each system:

System Description: Identify the areas of the building the system serves, the locations of performance checkpoints, the expected performance readings at the design load conditions and, where applicable, at part-load conditions. The system's operation during the day, night, and weekend, as well as seasonal start-up and shutdown, safety devices and their function, control devices and their function, pollution control devices, etc., also shall be described. The function of the controls for individual systems shall be described alongside the description of the system function.

Operating Routines and Procedures: Identify activities associated with the normal operation of systems and equipment. Operating checklists and operating logs shall be provided for each system and all performance standards shall be identified.

Seasonal Start-Up and Shutdown: List seasonal start-up and shutdown procedures, including any "mothballing" procedures required.

Special Procedures: Special procedures related to environmental control, health and safety, productive work environment, etc., shall be codified.

Troubleshooting Procedures: This section shall include questionnaires and diagnostics to allow users to isolate probable causes of operating problems in an efficient manner.

Maintenance manual: The maintenance manual shall be divided into two parts:

Part I shall contain information related to the equipment data sheets, nameplate data, operating data, etc. Include the original purchase order number; date of purchase; name, address, and phone number of vendor; and warranty information.

Part II shall support a maintenance program. The manual shall contain information prepared by the equipment manufacturers, but shall be supplemented by information provided by the Contractor. Each item of equipment shall be identified and an individual "Equipment Maintenance Sheet" shall be prepared for each, with the following information:

Description each system and system component, consisting of easily read schematic drawings showing all components, identified to match Part I data, that requires maintenance.

Recommended preventative and predictive maintenance procedures and their recommended frequency of application for each system component.

Recommended list of spare parts with part numbers and place(s) they can be obtained.

Copy of manufacturer's Installation instructions for each component.

Any other information requested by the A/E to support the operation and maintenance of the equipment.

Test reports: Provide copies of the test protocols used in the construction and commissioning of the systems. Arrange data so as to allow the results of ensuing tests to be easily added.

PART 2 - PRODUCTS

FIRESTOPPING SYSTEMS

Firestop systems shall be used in locations including, but not limited to, the following:

Penetrations through fire resistance rated floor assemblies and roof assemblies (where required by code) including both empty openings and openings containing penetrants.

Penetrations through fire resistance rated wall assemblies including both empty openings and openings containing penetrants.

Membrane penetrations in fire resistance rated wall assemblies where items penetrate one side of the barrier.

Membrane penetrations in fire resistance rated ceiling assemblies.

Systems or devices must be listed in the UL Fire Resistance Directory and must conform to construction type, penetrant type, annular space requirements and fire rating involved in each separate instance. System must be symmetrical for wall applications.

Systems or devices must be asbestos-free and all products must be from a single manufacturer.

Products must withstand the passage of cold smoke, either as an inherent property of the system or by the use of a separate product included as part of the UL system or device, and designed to perform this function.

Cracks, Voids, or Holes Up to 4" Diameter: Putty or caulking, one-piece intumescent elastomer, non-corrosive to metal, compatible with synthetic cable jackets, Listed, and capable of expanding 10 times when exposed to flame or heat.

Openings 4" or Greater: Sealing system capable of passing 3-hour fire test in accordance with ASTM E-814, consisting of wall wrap or liner, partitions, and end caps capable of expanding when exposed to temperatures of 250 to 350 deg. F (121 to 177 deg. C), Listed.

Wall Boxes:

Metallic boxes used in fire-rated walls or floors must be listed in the UL Fire Resistance Directory under category CEYY.

Listed single and double gang metallic device and outlet boxes with metallic or nonmetallic cover plates may be used in bearing and nonbearing wood stud and steel stud walls with ratings not exceeding 2 hours. The metallic outlet or switch boxes shall be securely fastened to the studs and the opening in the wallboard facing shall be cut so that the clearance between the box and the wallboard does not exceed 1/8 in. The surface area of individual metallic outlet or switch boxes shall not exceed 16 sq. in. The aggregate surface area of the boxes shall not exceed 100 sq. in. per 100 sq. ft. of wall surface.

Metallic boxes located on opposite sides of walls or partitions shall be separated by a minimum horizontal distance of 24 in. This minimum separation distance between metallic boxes may be reduced when “Wall Opening Protective Materials” listed in the UL Fire Resistance Directory under category CLIV are installed according to the requirements of the Classification.

Metallic boxes shall not be installed on opposite sides of walls or partitions of staggered stud construction unless “Wall Opening Protective Materials” are installed with the metallic boxes in accordance with Classification requirements for the protective materials.

WALL AND FLOOR ACCESS DOORS

Where floors, walls and ceilings must be penetrated for access to engineering work, provide types of access doors indicated, including floor doors if any. Furnish sizes indicated or, where not otherwise indicated, furnish 24" x 24" panels. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware.

Except as otherwise indicated, fabricate wall/ceiling door units of welded steel construction with welds ground smooth, 16-gage frames and 14-gage flush panel doors, 175 deg. swing with concealed spring hinges, flush screw-driver-operated cam locks, factory-applied rust-inhibitive prime-coat paint finish.

Provide rated access doors where installed in fire resistance rated floor and wall assemblies to meet fire rating.

PART 3 – EXECUTION

GENERAL

Comply with NFPA 241, *Standard for Safeguarding Construction, Alterations, and Demolition Operations*; ANSI A10 Series standards for *Safety Requirements for Construction and Demolition*; and Chapter 14 of the *North Carolina State Building Code: Fire Code*.

FIRE PROTECTION DURING CONSTRUCTION

Building contents and all elements of new and/or existing construction must be thoroughly protected from construction procedures that produce sparks, flames, or excessive heat. Such procedures include, but are not limited to, welding, soldering, flame-cutting, using grinders or metal cutting saws, and heating of work spaces. Contractor shall maintain fire watch and/or portable fire-suppression devices, as required, during these operations.

The Contractor shall develop, provide, and post a written plan in compliance with NFPA 241 and Chapter 14 of the *North Carolina State Building Code: Fire Code*.

Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures required to prevent fires and how to deal with them if they occur.

Provide and maintain portable, UL rated fire extinguishers with class and extinguishing agent as required by locations and classes of fire exposures. Comply with NFPA 10 *Standard for Portable Fire Extinguishers.* Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor or area at or near each usable stairwell.

SECURITY AND SAFETY DURING CONSTRUCTION

Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

MOISTURE AND MOLD CONTROL DURING CONSTRUCTION

Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

Protect porous materials from water damage.
Protect stored and installed material from flowing or standing water.

Keep porous and organic materials from coming into prolonged contact with concrete.

Keep roof, wall, and/or openings covered or dammed.

Partially Enclosed Construction Phase: After installation of weather barriers, but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

Do not load or install porous materials or components, or items with high organic content, into partially enclosed building.

Keep interior spaces reasonably clean and protected from water damage.

Periodically collect and remove waste containing cellulose or other organic matter.

Discard or replace water-damaged material.

Do not install material that is wet.

Discard, replace, or clean stored or installed material that begins to grow mold.

Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

Controlled Construction Phase of Construction: After completing and sealing of the building enclosure, maintain as follows:

Control moisture and humidity inside building by maintaining effective dry-in conditions.

Use **temporary** HVAC units or system to control humidity.

Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

Hygroscopic materials that may support mold growth that become wet during the course of construction and remain wet for 48 hours are considered defective and must be replaced.

DUST AND CONTAMINATION CONTROL DURING CONSTRUCTION

Prevent dust, fumes, and odors from entering occupied areas or areas in which construction work is more advanced

Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.

Maintain negative air pressure within the work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

Use vacuum collection attachments on dust-producing equipment. Isolate limited work areas using portable dust-containment devices.

Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

Coordinate general construction activities with the work of Divisions 23-28 to avoid contamination and/or degradation of building engineered systems by dust, over-spray of insulation or paint, etc. **Costs for the cleaning and/or component replacement of engineered systems required by contamination and/or degradation by general construction activities shall be assigned to the General Contractor.**

TEMPORARY HVAC SYSTEMS USE DURING CONSTRUCTION

The use of permanent HVAC systems to support construction activities is prohibited. The need for heating, cooling, dehumidification, and/or ventilation during construction shall be met via use of temporary HVAC units or systems as follows:

Heating: Provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.

Cooling: Provide modular, portable stand-alone direct expansion cooling units with condensers vented to the outdoors.

Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

COOPERATION WITH OTHER TRADES

The Contractor shall give full cooperation to other trades and shall furnish any and all information necessary to permit the work of other trades. Information to be provided by the Contractor includes, but is not limited to templates, patterns, setting plans, and shop details as may be necessary for the proper installation of work and for the purpose of coordinating adjacent work. Information required by other trades shall be provided in a timely manner and shall be sufficient to allow the work of such other trades to proceed with the least possible interference or delay.

Where the work of the Contractor will be installed in close proximity to, or may interfere with work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. **If the Contractor installs his work before coordination with other trades, he shall make the necessary changes in his work to correct the condition without extra charge.**

MISCELLANEOUS CONCRETE AND STEEL SUPPORTS

All concrete curbs, bases, etc., required for mechanical or electrical equipment and components shall be provided under the Division requiring them except where specifically indicated and/or specified to be provided under a different Division.

"Housekeeping pads", constructed of 3000 psi concrete doweled to floor slab, shall be provided for each floor-mounted component. Pads for air-handling units shall, unless indicated otherwise on the drawings, be 6" high, while pads for all other equipment shall be 4" high. Pads shall be finished smooth with chamfered top edges and corners. Equipment and other floor-mounted elements shall be installed and shall be anchored and grouted to housekeeping pads.

Miscellaneous steel for equipment, pipe, duct, raceway, etc. installation required by the work in any Division shall be provided and placed under that Division except where specifically indicated and/or specified to be provided under a different Division.

Anchors, inserts, supports, attachments, etc., required and but not indicated on the Drawings shall be provided under this Contract.

FIRESTOPPING

Installer should be experienced in installing or applying similar systems, plus: be acceptable to or licensed by manufacturer, state or local authority where applicable; have at least five years experience; and have successfully completed at least five comparable projects using this system.

Firestop systems or devices installation must meet requirements of ASTM E-814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

Install only after substrate penetrations and supporting brackets have been installed. Do not install firestopping when ambient or substrate temperatures are outside limits permitted by manufacturers or when substrates are wet. Where floor openings without penetrating items are more than 4 inches wide and subject to traffic or loading, install firestopping materials capable of supporting same loading as floor. Protect materials on surfaces subject to traffic.

SMOKE-RESISTIVE SYSTEMS

The space around items penetrating non-fire rated walls and floors shall be filled with an approved material to limit the free passage of smoke, heat and flame in locations including, but not limited to, the following:

Penetrations through non-rated floors including both empty openings and openings containing penetrants.

Penetrations through non-rated smoke partitions and wall assemblies including both empty openings and openings containing penetrants.

WALL AND FLOOR ACCESS DOORS

Comply with manufacturer's instructions for installation of access doors, floor doors, and removable access plates.

Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.

Adjust hardware and panels after installation for proper operation.

Remove or replace panels or frames that are warped, bowed, or otherwise damaged.

PATCHING

Repair, patching, and finishing of walls, floors, and/or ceilings affected by demolition, cutting after installation of new work, etc. shall be done by technicians skilled in the applicable trades and shall match surrounding or adjoining materials in composition, texture, color, and finish.

CONTRACTOR AS-BUILT DRAWINGS

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

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

Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.

Accurately record information in an acceptable drawing technique.

Record data as soon as possible after obtaining it.

Record and check the markup before enclosing concealed installations.

Cross-reference record prints to corresponding archive photographic documentation.

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

Dimensional changes.

Revisions to details.

Locations and depths of underground utilities.

Revisions to routing of piping and conduits.

Revisions to electrical circuitry.

Actual equipment locations.

Duct size and routing.

Locations of concealed internal utilities.

Additional information that was either shown schematically or omitted from original Drawings.

Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

Submit Contractor As-built Drawings to A/E for review **at least two (2) weeks prior to Project final inspection**.

END SECTION 019913

SUBMITTAL COVER FORM

PROJECT: North Campus NE Building Lab Upfit
Cape Fear Community College

PROJECT NO.: 0574-03-00-20

TO: STANFORD WHITE, INC.
1620 Midtown Place
Raleigh, NC 27609

FROM: _____

_____

_____

_____

_____ CONTRACTOR _____ SUBCONTRACTOR

We submit for your consideration the following product for the above project:

SPECIFICATION SECTION	SPECIFICATION PARAGRAPH	DESCRIPTION

TYPE OF SUBMITTAL:

_____ Specified Brand Product
_____ Proposed Equivalent Product to Specified Brand
_____ Product Meeting Performance Specification (No Brand Specified)

We warrant the following:

a. We have personally investigated the proposed product, and determined that it is equal in all respects to that specified and/or performance specification requirements;

b. We will provide the specified guarantee for this product;

c. We will coordinate installation of this product into the work, making such changes as may be required for the work to be complete in all respects;

d. We have clearly indicated by marking as "Non-Complying Feature" each and every requirement of the Specifications that this product does not meet;

e. And, we waive all claims for additional costs related to this product which subsequently become apparent.

Attached hereto are complete technical data, including applicable laboratory reports, to demonstrate compliance with project requirements.

SUBMITTED BY:

_____ _____
SIGNATURE DATE

SUBMITTAL REVIEW

(SAMPLE FORM - ORIGINAL WITH COMMENTS WILL BE ATTACHED TO SUBMITTAL BY A/E)

PROJECT:

PROJECT #:

SUBMITTAL ID#:

SPECIFICATION PARAGRAPH:

DESCRIPTION:

Submittal has been reviewed only for conformance with design intent of the contract documents. See Section 019913 "GENERAL REQUIREMENTS FOR ENGINEERED WORK" for complete definition of Submittal Review.

☐ Reviewed

☐ Exceptions Noted - Revise & Proceed

☐ Exceptions Noted - Revise & Resubmit

☐ Rejected

DATE:

BY:

REVIEW COMMENTS:

THESE COMMENTS SHALL NOT BE REMOVED FROM THIS DOCUMENT

SECTION 019916 - DIVISIONS 23-28 WORK IN EXISTING BUILDINGS

PART 1 - GENERAL

RELATED DOCUMENTS

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

SUMMARY

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

The requirements specified herein shall govern all Sections in Divisions 23-28, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

SUBMITTALS

Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

DEFINITIONS

Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.

Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

MATERIALS OWNERSHIP

Unless otherwise indicated, demolition waste becomes property of Contractor. Materials removed during demolition shall be accumulated in the demolition area for examination by the Owner. The Owner may choose to retain selected items. Items not selected to be retained by the Owner become the property of the Contractor and shall be removed from the site in a timely manner. All disposal fees and/or permits shall be the responsibility of the Contractor.

QUALITY ASSURANCE

Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved Section 608 certification program.

FIELD CONDITIONS

Existing facilities shall remain in use during all phases of construction under this Contract. **All and any of existing building safeties such as exit signage, exit lights, fire alarm, fire sprinkler etc., must remain operational CONTINUOUSLY in order to retain building occupancy status. All required exits and exit signs must be kept available and free of obstruction at all times.** The Contractor shall cooperate with the Owner in every way possible to keep interruption of, and interference with, normal functions, activities, and operations to a minimum.

Where construction or attendant work interrupts normal functions in any area, a schedule of work shall be submitted for approval of the Owner and after approval, strictly followed. Modification to existing work shall be done as required. All work shall be performed in such a manner as to prevent any interruption of any service or utility. Where it is necessary to interrupt service for demolition, cut-in, or changeover, the work shall be scheduled well in advance of the interruption and the interruption approved by the Owner. As required by the Owner, such work shall be done during night, weekends, holidays, or other off-peak period as approved.

Existing piping, ductwork, raceway and wiring, etc., shall be modified as indicated on the Drawings and/or as required by new and modified construction. Existing piping, ductwork, raceway and wiring, etc., shall be modified as required and put in first class operating condition. No equipment shall be disconnected without approval of the Owner's Representative. Temporary relocation of equipment and temporary piping, ductwork, wiring and raceway, etc., required for continued operation of the facility shall be provided as required.

PART 3 - EXECUTION

PERFORMANCE REQUIREMENTS

Comply with governing EPA notification regulations before beginning selective demolition.

Comply with hauling and disposal regulations of authorities having jurisdiction.

EXISTING FACILITY ACCESS

Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

Do not load elevators beyond their rated weight capacity.

Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

Existing Stair Use: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.

Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

EXAMINATION AND PREPARATION

Verify that utilities have been disconnected and capped, valved off, or otherwise secured before starting demolition.

Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to the A/E.

Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain. As necessary, provide dust barriers, noise control, etc. to minimize impact of demolition on adjacent occupied areas.

Provide protection to ensure safe passage of people around demolition area and to and from occupied portions of building.

Provide temporary weather protection, during interval between demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

Provide heating, cooling, dehumidification, and ventilation as necessary to protect the existing building materials and finishes during the demolition period.

Where existing plumbing, fire protection, HVAC, or electrical services in demolition areas must be shutdown, temporary plumbing, fire protection, heating, cooling, dehumidification, ventilation, lighting, and electrical power shall be provided as needed to maintain use of adjacent occupied areas that are negatively impacted by the shutdown.

Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

Cover and protect furniture, furnishings, and equipment that have not been removed.

Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

GENERAL CONSTRUCTION DEMOLITION

Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and/or portable fire-suppression devices, as required, during flame-cutting operations.

Maintain adequate ventilation when using cutting torches.

Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

Dispose of demolished items and materials promptly.

Protect construction indicated to remain against damage and soiling during demolition.

MECHANICAL DEMOLITION

Remove or relocate all mechanical elements (devices, fixtures, controls, etc.) from walls or floors indicated as being demolished.

Thermostats and sensors containing mercury shall be disposed in accordance with EPA Resource Conservation and Recovery Act (RCRA). Contractor shall refer to EPA web site for handling procedures for disposal and spill management of projects containing mercury.

Extend or relocate any existing piping and or ductwork serving existing equipment to remain or other items where such circuits are disrupted due to demolition.
Remove all abandoned piping back to the point of supply or back to the point where other remaining piping is connected. For existing piping imbedded existing walls or floors that are not to be demolished, remove piping to behind finish surface, cap, and patch wall or floor as specified hereinafter.

Existing HVAC systems serving both occupied areas and construction areas shall be modified as required to isolate the construction area. Ducts shall be sealed by closing dampers, disconnecting ducts and sealing openings with 6-mil polyvinyl sheeting, etc.

HVAC equipment in construction areas that is required to be reused shall be de-energized and protected from construction dust and debris with 6-mil polyvinyl sheeting during construction. HVAC systems that are modified during renovation shall be sealed until modifications are made and then resealed until start-up is required. After unsealing of equipment, coils and drain pans of air-handling equipment shall be cleaned.

Recover and recycle refrigerants from existing equipment to be demolished. All demolition work of existing systems containing refrigerant must be conducted in accordance with Section 608 of EPA Clean Air Act under supervision of an EPA certified technician. Provide documentation with types, quantities and dates for the engineers and owners record.

Control or monitoring systems that protect equipment and/or occupants must be maintained until associated equipment is removed.

ELECTRICAL DEMOLITION

Coordinate all electrical outages with the Owner to facilitate reworking of existing system. No service, feeder, or branch circuit may be de-energized unless specific approval has been obtained from the Owner's representative.

Dispose of Removed Equipment and Material: Materials removed and not indicated by Drawings to be reinstalled, stored, or retained by the Owner, shall be removed from the site in a timely manner at the Contractor's expense.

The Owner may choose to retain selected items or equipment. The Contractor shall remove and deliver such items and/or equipment to a location on site as requested by the Owner.

Thoroughly inspect electrical systems in reworked areas and bring to the attention of the A-E all defective or unserviceable material not scheduled for removal or replacement.

Remove all abandoned wiring, both exposed and concealed.

Remove all abandoned raceway and any related items, both exposed and concealed. Where existing raceway is concealed in concrete or masonry, remove wiring as required above and abandon in place. Cut abandoned raceway off ½" into wall, ceiling, or floor to allow patching to completely cover cut off end of raceway.

Repair surfaces and finishes to match existing surrounding surfaces or finish in all areas where items are removed. After repairs are made no evidence of previous use of surfaces shall be visible.

Provide touch-up painting as required where new items are installed adjacent to existing items to remain.

Clean new, damaged, and/or disturbed areas and apply primer, intermediate, and finish coats at each location.

Surface preparation and timing of application of successive coats of paint shall be in accordance with paint manufacturer's instructions.

Use zinc-rich paint to repair damage to galvanized finishes. Follow written instructions of paint manufacturer.

Repair paint finishes for other items, surfaces, or equipment as necessary. Follow written instructions of paint manufacturer.

Provide blank cover plates to match device plates used in the adjoining areas where outlet, device, junction, or other boxes are to remain,

Perform the electrical demolition as described below:

Remove all electrical raceway, cable, wiring, devices, junction boxes, fittings, and related items from all locations indicated on the Drawings as being renovated. Existing raceway, junction boxes, fittings, and similar items may only be reused for the present project where explicitly indicated on the Drawings, provided:

The existing item is in good condition and is suitable for reuse.

The existing items meets the requirements of the Specifications for similar items which might be provided new in other locations on the project. Additional support and/or fire stopping may be required to meet this condition.

The existing item is located in the same position as required in the new configuration as shown on the Drawings.

Extend or relocate all existing circuits and related items serving existing utilization or other equipment where such circuits or items are disrupted due to demolition activities of any division of the Contract Documents. Relocate all existing junction boxes or similar items that will be rendered inaccessible by new construction furnished under any division of the Contract Documents. Provide any and all temporary electrical supply (supplies) as needed to meet this requirement.

Remove all abandoned circuits back to the point of supply or back to the point where other remaining loads are connected. Label any unused overcurrent devices as "SPARE". Circuits supplying equipment which is removed or demolished by any division of the Contract Documents is considered as "abandoned" for purposes of this requirement.

Revise existing panel directories to reflect modifications made as a part of the project. All directory revisions shall be typed.

LIGHT FIXTURE DISPOSAL

Lighting fixtures shall be expected to contain ballasts containing Polychlorinated Biphenyls (PCB's). The Contractor shall dispose of these ballasts by collecting them in metal drums, and shall transport these drums to an approved disposal site. The Contractor's responsibility shall be to properly collect the ballasts and turn them over to a hazmat disposal facility.

On all fixtures to be demolished the Contractor shall open the wiring compartments of the lighting fixture and determine if the lighting fixture contains ballast(s) with Polychlorinated Biphenyls (PCB's.) Non PCB-containing ballasts will have printed on their labels "NO PCB's". If the ballast label is missing, illegible, or not explicitly labeled "NO PCBs," the ballast shall be considered to contain PCBs. Ballasts explicitly stating "NO PCBs" shall be disposed of by the Contractor as a part of the normal demolition of material in the project. All other ballasts (missing labels, illegible labels, or those ballasts not explicitly marked "NO PCBs") shall have their wires cut close to the ballasts and be removed from the lighting fixtures.

In addition, Contractor shall expect that all lamps contain mercury. The Contractor shall dispose of these lamps by collecting them in a manner that keeps the lamps intact and turn them over to a properly permitted light recycler.

END OF SECTION 019916

SECTION 019926 - OWNER INSTRUCTION AND TRAINING FOR DIVISIONS 23-28 WORK

PART 1 - GENERAL

RELATED DOCUMENTS

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

The requirements specified herein shall govern all Sections in Divisions 23-28, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

QUALITY ASSURANCE

The Owner instruction and training program shall be developed and coordinated by a firm or individual experienced in training or educating maintenance personnel.

Contractor personnel experienced in the systems and components incorporated in this Project, along with factory-authorized service representatives, shall perform the instruction.

COORDINATION

Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

Coordinate content of training modules with content of manufacturers' recommended emergency, operation, and maintenance procedures.

PART 2 - PRODUCTS

INSTRUCTION PROGRAM

General: **The Contractor(s) for each of Divisions 23-28, as applicable, is responsible for instructing Owner's personnel relative to each Division's work**, including the following:

Instruction in the operation of systems, subsystems, and equipment.

Training in maintenance of systems, subsystems, and equipment.

Program Structure: Develop an instruction and training program that includes individual training modules for each Division 21-28 system, subsystem, and equipment item, including both classroom instruction and "hands-on" demonstrations.

Training Modules: Develop a learning objective and teaching outline for each instruction and training module, taking into consideration the level of proficiency of Owner's maintenance staff. Include a description of specific skills and knowledge that each participant is expected to master.

For each instruction and training module, include instruction for the following, as applicable to the system, subsystem, equipment, or component:

Documentation: Review the following items in detail:

Operations manuals.

Maintenance manuals.

Project record documents.

Warranties, bonds, and guarantees.

Maintenance service agreements and similar continuing commitments.

Emergencies: Include the following, as applicable:

Instructions on meaning of warnings, trouble indications, and error messages.

Shutdown instructions for each type of emergency.

Operating instructions for conditions outside of normal operating limits.

Sequences for electric or electronic control systems.

Special operating instructions and procedures.

Operations: Include the following, as applicable:

Startup procedures.

Equipment or system break-in procedures.

Routine and normal operating instructions.

Regulation and control procedures.

Control sequences.

Safety procedures.

Normal start-up and shutdown instructions.

Operating procedures for emergencies.

Operating procedures for system, subsystem, or equipment failure.

Required sequences for electric or electronic control systems.

Special operating instructions and procedures.

Adjustments: Include the following:

Alignments.

Routine adjustments, tightening, etc.

Noise and vibration adjustments.

Economy and efficiency adjustments.

Maintenance: Demonstrate the following:

Inspection procedures.

Preventative maintenance requirements, consisting of the following:

Routine maintenance, which consists of specific procedures that are performed on a regular schedule and are designed to detect, preclude, or mitigate degradation of a system or its components.

Predictive maintenance, which uses routine inspection and evaluation, testing, and analysis to augment routine maintenance procedures by detecting the onset of component degradation and to address problems as they are identified.

Instruction on use of special tools.

Repairs: Include the following:

Troubleshooting and diagnostic instructions.

Test and inspection procedures.

Repair instructions.

Disassembly; component removal, repair, and replacement; and reassembly instructions.

Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

Owner will furnish an instructor to describe Owner's operational philosophy.

Owner will furnish Contractor with names and positions of participants to attend instruction and training, not to exceed 10 individuals.

Provide instruction at mutually agreed on times scheduled at least four (4) weeks in advance through the A/E. For systems, subsystem, and/or equipment that requires seasonal operation, provide required instruction at start of each season.

Conduct training on-site in the completed and fully operational facility in classroom/conference space provided by the Owner and using the actual systems, subsystems, and equipment installed.

Conduct training using final operation and maintenance data submittals as the training reference material. If additional training materials are utilized, they shall be incorporated as an appendix to the operation and maintenance data submittals.

Provide documentation that Owner instruction and training has taken place. Provide record of dates, topics, and duration of each training session, the names of Owner's staff who participated, and a signed review form by each participant.

END OF SECTION 019926

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Glass-fiber blanket insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BLANKET INSULATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. CertainTeed Corporation.
   2. Guardian Building Products, Inc.
   3. Johns Manville; a Berkshire Hathaway company.
   4. Knauf Insulation.
   5. Owens Corning.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

PART 3 - EXECUTION

3.1 PREPARATION

A. A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Glass-Fiber or Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically.
5. Use pre-formed mineral wool safing insulation at top of walls and friction fit in flutes of metal roof or floor deck at rated walls.

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Latex joint sealants, including Acoustical joint sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:

   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.
   1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.6 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:
1. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.
2. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Construction Chemicals, LLC Building Systems: Sonolac.
b. Pecora Corporation: AC-20.
c. Sherwin-Williams Company (The): 850A.
d. Tremco Incorporated: Tremflex 834.

2.3 JOINT-SEALANT BACKING

A. A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Construction Chemicals, LLC Building Systems.
b. Construction Foam Products, a division of Nomaco, Inc.
c. Backer Rod Manufacturing, Inc.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

   2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

      a. Concrete.
      b. Masonry.

   3. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

      a. Metal.
      b. Glass.
      c. Porcelain enamel.
      d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Vertical joints on exposed surfaces of unit masonry walls and partitions.
c. Other joints as indicated on Drawings.

END OF SECTION 079200

SECTION 079500 - EXPANSION CONTROL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Interior expansion control systems.

B. Related Requirements:
   1. Section 092900 “ Gypsum Board"

1.3 ACTION SUBMITTALS

A. Shop Drawings: For each expansion control system specified. Include plans, elevations, sections, details, splices, blockout requirement, attachments to other work, and line diagrams showing entire route of each expansion control system. Where expansion control systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

B. Samples: For each exposed expansion control system and for each color and texture specified, full width by 6 inches (150 mm) long in size.

C. Samples for Initial Selection: For each type of expansion control system indicated.
   1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

D. Samples for Verification: For each type of expansion control system indicated, full width by 6 inches (150 mm) long in size.

E. Product Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
   1. Manufacturer and model number for each expansion control system.
   2. Expansion control system location cross-referenced to Drawings.
   3. Nominal joint width.
   4. Movement capability.
   5. Classification as thermal or seismic.
   6. Materials, colors, and finishes.
   7. Product options.
   8. Fire-resistance ratings.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. General: Provide expansion control systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.
   1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where expansion control systems change direction or abut other materials.

   2. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion control systems.

B. Coordination: Coordinate installation of exterior wall and soffit expansion control systems with roof expansion control systems to ensure that wall transitions are watertight. Roof expansion joint assemblies are specified elsewhere.

2.2 INTERIOR EXPANSION CONTROL SYSTEMS

A. A. Manufacturers: Subject to compliance with requirements, provide product indicated or comparable products by the following:
   1. C/S Group
   2. MM Systems
   3. InPro Corporation
   4. Balco, Inc.
   5. Nystrom, Inc.

B. Source Limitations: Obtain expansion control systems from single source from single manufacturer.

C. Wall-to-Wall, Ceiling-to-Ceiling:

   1. Basis-of-Design Product: C-S Group, Model FWF-200

   2. Design Criteria:
      a. Nominal Joint Width: 2-inches.
      b. Movement Capability: +/- 50% minimum
      c. Load Capacity: Standard duty
      d. Attachment Method: Mechanical anchors

   3. Type: Single extruded gasket in extruded aluminum frame.
      a. Metal: Aluminum.
         1) Finish: Mill.
      b. Seal Material: Thermoplastic Rubber (TPR).
         1) Color: As selected by Architect from manufacturer's full range.
         2) Gaskets to be dual durometer and have a flat profile that is free of ridges/ reveals that collect dirt.

2.3 MATERIALS

A. Aluminum: ASTM B 221, Alloy 6063-T5 for extrusions; ASTM B 209, Alloy 6061-T6 for sheet and plate.
    1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Elastomeric Seals: ASTM E 1783; preformed elastomeric membranes or extrusions to be installed in metal frames.

C. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

D. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.4 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion control systems will be installed for installation tolerances and other conditions affecting performance of work.
    1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion control system manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion control systems. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion control systems.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion control systems and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion control systems.

1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.

2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation. Notify Architect where discrepancies occur that will affect proper expansion control system installation and performance.

3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.

4. Repair or grout blockout as required for continuous frame support using nonmetallic, shrinkage-resistant grout.

5. Install frames in continuous contact with adjacent surfaces.
   a. Shimming is not permitted.

6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.

C. Seals in Metal Frames: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions according to manufacturer's written instructions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Terminate exposed ends of expansion control systems with field- or factory-fabricated termination devices.

3.4 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion control systems. Reinstall cover plates or seals prior to Final Acceptance of the Work.

END OF SECTION 079500

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Hollow-metal work.

B. Related Requirements:
   1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.
   2. Division 08: Wood doors for installation in steel frames.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.

B. Shop Drawings: Include the following:
   1. Elevation of each door frame type.
   2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   3. Locations of reinforcement and preparations for hardware.
   4. Details of each different wall opening condition.
   5. Details of anchorages, joints, field splices, and connections.
   6. Details of accessories.

C. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.7 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.8 QUALITY ASSURANCE

A. Quality Standard: Comply with SDI 100.

B. Coordination: Transmit copy of final shop drawings to wood door manufacturer to allow prefitting of wood doors to steel frames.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amweld Building Products, Inc.
2. Ceco Door; ASSA ABLOY.
3. Curries Company; ASSA ABLOY.
4. Republic Doors and Frames.
5. Steelcraft; an Ingersoll-Rand brand.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2. *At all interior locations indicated to be HD Steel.*
1. Physical Performance: Level B according to SDI A250.4.
2. Frames:
a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch.
b. Construction: Knock-down type.

3. Exposed Finish: Prime.

2.7 FRAME ANCHORS

A. Jamb Anchors:
   1. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.

2.8 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

2.9 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

   1. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

      a. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

   1. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

   2. All frames to be equal rabbeted.

2.10 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

B. Hollow-Metal Frames: Install hollow-metal frames for doors, transoms, sidelites, borrowed lites, and other openings, of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

2. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.

3. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Solid-core doors with wood-veneer faces.
   2. Factory finishing flush wood doors – fire rated and non-rated doors.

B. Related Requirements:
   1. Section 081113 “Hollow Metal Doors and Frames”.
   2. Section 087100 “Door Hardware”.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction, and trim for openings. Include factory-finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:

   1. Dimensions and locations of blocking.
   2. Dimensions and locations of mortises and holes for hardware.
   3. Dimensions and locations of cutouts.
   4. Undercuts.
   5. Requirements for veneer matching.
   6. Doors to be factory finished and finish requirements.

C. Samples for Initial Selection: For factory-finished doors.

D. Samples for Verification:
   1. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.
      a. Provide Samples for each species of veneer and solid lumber required.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.
B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is a certified participant in AWI's Quality Certification Program.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.
B. Package doors individually in plastic bags or cardboard cartons.
C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

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

        a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
        b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

    2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

    3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    1. VT Industries Inc. (Match existing)

2.2 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."

1. Provide AWI Quality Certification Labels indicating that doors comply with requirements of grades specified.

B. WDMA I.S.1-A Performance Grade:
   1. Heavy Duty unless otherwise indicated.

C. Particleboard-Core Doors:
   1. Particleboard: ANSI A208.1, Grade LD-2, made with binder containing no urea-formaldehyde.

   2. Blocking: Provide wood blocking in particleboard-core doors as follows:

      a. 5-inch top-rail blocking, in doors indicated to have closers.
      b. 5-inch bottom-rail blocking, in doors indicated to have kick, mop, or armor plates.
      c. 5-inch midrail blocking, in doors indicated to have exit devices

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:

   1. Grade: Premium, with Grade A faces
   2. Species: Select red oak.
   3. Cut: Plain sliced (flat sliced).
   4. Match between Veneer Leaves: Book match.
   5. Assembly of Veneer Leaves on Door Faces: Running match.
   6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
   7. Core: Particleboard.
   8. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press.

2.4 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
   1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.

2.5 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Factory finish doors.

C. Use only paints and coatings that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Transparent Finish:

1. Grade: Premium.
2. Finish: WDMA TR-6 catalyzed polyurethane.
3. Staining: Alpine 07 (VT Industries, Basis of Design)
4. Effect: Open-grain finish.
5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames, with Installer present, before hanging doors.

1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

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

3.2 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide1/4 inch from bottom of door to top of threshold unless otherwise indicated.

2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Mechanical door hardware for the following:
    a. Swinging doors.

B. Related Sections:

1. Section 081113 "Hollow Metal Doors and Frames" for door silencers provided as part of hollow-metal frames.

2. Section 081416 "Flush Wood Doors"

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.

2. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.

3. Content: Include the following information:

    a. Identification number, location, hand, fire rating, size, and material of each door and frame.

    b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.

c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

d. Fastenings and other pertinent information.

e. Explanation of abbreviations, symbols, and codes contained in schedule.

f. Mounting locations for door hardware.

4. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Architectural Hardware Consultant.

B. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

1.8 COORDINATION

A. Coordinate layout and installation of floor-recessed door hardware with floor construction.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

D. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing

conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.9 W ARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fails in materials or workmanship within specified warranty period.

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

a. Structural failures including excessive deflection, cracking, or breakage.

b. Faulty operation of doors and door hardware.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Project Completion, unless otherwise indicated.

a. Manual Closers: 10 years from date of Project Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.

2.2 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

B. Basis of Design: HB Ives, 5BB1HW, 5BB1

2.3 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required as follows:

1. Mortise Locks: Minimum 3/4-inch latchbolt throw.

C. Lock Backset: 2-3/4 inches, unless otherwise indicated.

D. Lock Trim:
1. Description: Match existing.

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

F. Mortise Locks: BHMA A156.13; Operational and Security Grade 1 stamped steel case with steel or brass parts; Series 1000.

G. Basis of Design: Corbin Russwin ML2000, LWA, US26D

2.4 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

2.5 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

1. Manufacturer: Same manufacturer as for locking devices.

B. Standard Lock Cylinders: BHMA A156.5; Grade 1; non-removable cores; face finished to match lockset.

2.6 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMAA156.28.

1. Existing System: Corbin Russwin.

2. Key locks to Owner's existing system.

B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: "DO NOT DUPLICATE.”

2. Quantity: In addition to one extra key blank for each lock, provide the following:

a. Cylinder Change Keys: Three.

2.7 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

B. Basis of Design Product: Subject to compliance with requirements, provide LCN, 4041Series.

2.8 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.9 FINISHES

A. Provide finishes that match existing.

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

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

3.2 PREPARATION

A. Wood Doors: Comply with DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install permanent cores.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Project Completion.

END OF SECTION 087100

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Non-load-bearing steel framing systems for interior gypsum board assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 FRAMING SYSTEMS

A. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.
   1. Steel Studs and Runners:
      a. Minimum Base-Metal Thickness: 0.033 inch.
      b. Depth: As indicated on Drawings.

   2. Dimpled Steel Studs and Runners:
      a. Minimum Base-Metal Thickness: 0.025 inch.
      b. Depth: As indicated on Drawings.

B. Slip-Type Head Joints: Where indicated, provide one of the following:

   1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

         1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
         2) MBA Building Supplies; FlatSteel Deflection Track and Slotted Deflecto Track.
         3) Steel Network, Inc. (The); VertiTrack VTD and VTX Series.
         4) MarinoWare, A Division of WareIndustries.

C. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Minimum Base-Metal Thickness: 0.033 inch.
   2. Depth: As indicated on Drawings.

2.2 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

   1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:
   1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

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

3.2 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

   1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install bracing at terminations in assemblies.

C. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.3 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.

    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Interior gypsum board.

B. Related Requirements:
   1. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For the following products:

   1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Low-Emitting Materials: For ceiling and wall assemblies, provide materials and construction identical to those tested in assembly and complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products manufactured by one of the following:

1. American Gypsum.
2. CertainTeed Corporation.
3. Georgia-Pacific Building Products.
4. Lafarge North America Inc..
5. National Gypsum Company.
6. USG Corporation.

B. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

2.4 TRIM AND ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
   a. Cornerbead.
   b. LC-Bead: J-shaped; exposed long flange receives joint compound.
   c. L-Bead: L-shaped; exposed long flange receives joint compound.
   d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
   e. Expansion (control) joint.
   f. “F”-Reveal Molding

2.5 JOINT TREATMENT MATERIALS

A. General: Provide products by manufacturer of gypsum boards. Comply with ASTM C 475/C 475M and with manufacturer's recommendations for specific project conditions.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

2. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

a. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.

b. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping or drying-type, all-purpose compound.

3. Fill Coat: For second coat, use setting-type, sandable topping or drying-type, all-purpose compound.

4. Finish Coat: For third coat, use setting-type, sandable topping or drying-type, all-purpose compound.

5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

C. Sound Attenuating Batt Insulation: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

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

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

C. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

D. Form control and expansion joints with space between edges of adjoining gypsum panels.

E. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.

2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

F. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
1. Wallboard Type: As indicated on Drawings.

B. Single-Layer Application:

1. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

    b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.
2. LC-Bead: Use at exposed panel edges.
3. L-Bead: Use where indicated.
4. U-Bead: Use where indicated.

3.5 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
    1. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
        a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.6 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Resilient base.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.

B. After installation and until Final Acceptance, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. FloorScore Compliance: Resilient base and stair accessories shall comply with requirements of FloorScore certification.

2.2 THERMOPLASTIC-RUBBER BASE

A. Manufacturers: Subject to compliance with requirements, provide products indicated on Drawings or comparable product by one of the following:

1. Roppe Corporation, USA. (BASIS OF DESIGN)

B. Product Standard: ASTM F 1861, Type TS (rubber, thermoset).

1. Group: I (solid, homogeneous).

2. Style and Location:

a. Style B, Cove: Provide in accordance with drawings at locations scheduled to receive sealed concrete or resilient flooring/linoleum.

1) Profile: Toe.

C. Thickness: 0.125 inch.
D. Height: 4 inches.
E. Lengths: Coils in manufacturer's standard length.
F. Outside Corners: Job formed.
G. Inside Corners: Job formed.
H. Colors: Match existing.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

1. Adhesives shall have a VOC content of 50 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

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

3. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until they are the same temperature as the space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Job-Formed Corners:
1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

    a. Miter or cope corners to minimize open joints.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum horizontal surfaces thoroughly.
3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Final Acceptance.

END OF SECTION 096513

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates:
   1. Steel.
   2. Gypsum board.
   3. Cotton or canvas insulation covering.

1.3 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

   1. Submit Samples on rigid backing, 8 inches square.
   2. Step coats on Samples to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

C. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Benjamin Moore & Co.
2. Duron, Inc.
3. PPG Architectural Finishes, Inc.
4. Pratt & Lambert.
5. Sherwin Williams.
6. Sherwin-Williams; Paint Stores Group.

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.
4. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
5. Colors: To match existing.

2.3 PRIMERS/SEALERS

A. Primer Sealer, Latex, Interior: MPI #50.

1. Sherwin Williams, Promar 200 Interior Latex Primer.
2. PPG, Speedhide interior latex sealer, quick drying.
3. Benjamin Moore, Super Spec Premium Interior Latex Primer.

2.5 METAL PRIMERS

A. Primer, Alkyd, Anti-Corrosive, for Metal: MPI #79.

1. Sherwin Williams, Kemkormic Universal Primer.
2. PPG, Speedhide Int/Ext Rust Inhibiting Steel Primer.
3. Benjamin Moore, Super Spec HP Alkyd Metal Primer.

2.6 WATER-BASED PAINTS

A. Latex, Interior, Flat, (Gloss Level 1): MPI #53.

1. Sherwin Williams, SuperPaint Interior Flat Latex.
2. PPG, SpeedHide Interior Latex Flat.
3. Benjamin Moore, Super Spec Interior Latex Flat.

B. Latex, Interior, (Gloss Level 2): MPI #44.

1. Sherwin Williams, ProMar 200 Interior Latex EG-Shell.
2. PPG, SpeedHide Indoor Enamel Latex Eggshell.
3. Benjamin Moore, Super Spec Interior Latex Eggshell.

C. Latex, Interior, Semi-Gloss, (Gloss Level 5): MPI #54.

1. Sherwin Williams, ProMar 200, Interior Latex Semi-Gloss.
2. PPG, SpeedHide Interior Enamel Latex Semi-Gloss.
3. Benjamin Moore, Interior 100% Acrylic Semi-Gloss.

D. Latex, Interior, High Performance Architectural, (Gloss Level 2): MPI #138.

1. Sherwin Williams, SuperPaint Interior Latex Satin.
2. PPG, SpeedHide High Solids Interior Enamel Eggshell Latex.
3. Benjamin Moore, Premium Interior Paint and Primer Eggshell.

E. Latex, Interior, High Performance Architectural, (Gloss Level 3): MPI #139.

1. Sherwin Williams, 100 Acrylic Interior Lo-Lustre Eggshell.
2. PPG, Dulox Lifemaster, Interior 100% Acrylic Latex Pearl.
3. Benjamin Moore, Premium Interior 100% Acrylic Eggshell.

2.7 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.

2. Testing agency will perform tests for compliance with product requirements.

3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Gypsum Board: 12 percent.
2. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

3. Paint front of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

a. Paint the following work where exposed in occupied spaces: Metal conduit on wall surfaces.

b. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

c. Other items as directed by Architect.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.

2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. Steel Substrates:

1. Latex over Alkyd Primer System:
   a. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
   b. Intermediate Coat: Latex, interior, matching topcoat.
   c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

B. Gypsum Board Substrates:

1. High-Performance Architectural Latex System:

   a. Prime Coat: Primer sealer, latex, interior, MPI #50.
   b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
   c. Topcoat: Latex, interior, high performance architectural, (Gloss Level 3), MPI #139.

C. Cotton or Canvas and ASJ Insulation-Covering Substrates: Including pipe and duct coverings.

1. Latex System:
   a. Prime Coat: Primer sealer, latex, interior, MPI #50.
   b. Intermediate Coat: Latex, interior, matching topcoat.
   c. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.

END OF SECTION 099123

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Manually operated roller shades with single rollers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

C. Samples: For each exposed product and for each color and texture specified, 10 inches long.

D. Samples for Verification: For each type of roller shade.

   1. Shadeband Material: Not less than 10 inches square. Mark inside face of material if applicable.

   2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.

   3. Installation Accessories: Full-size unit, not less than 10 inches long.

E. Roller-Shade Schedule: Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material, signed by product manufacturer.

C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.10 WARRANTY

A. Roller Shade Hardware and Chain Warranty: Manufacturer's standard non-depreciating warranty for interior shading.

1. Shade Hardware: 10 years unless otherwise indicated.
2. Standard Shadecloth: Manufacturer's standard twenty-five year warranty.
3. Ecoveil Shadecloth: Manufacturer's standard ten year warranty.
4. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas, which are deemed owners responsibility.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Draper Inc.
2. Hunter Douglas Contract.
3. Lutron Electronics Co., Inc. (BASIS OF DESIGN)
4. MechoShade Systems, Inc.

B. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Bead Chains: Nickel-plated metal .

a. Loop Length: Full length of roller shade.
b. Limit Stops: Provide upper and lower ball stops.
c. Chain-Retainer Type: Clip, jamb mount.

2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller-shade weight and lifting heavy roller shades.

a. Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criteria are more stringent.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: As determined by Owner.
2. Direction of Shadeband Roll: Reverse, from front of roller.
3. Shadeband-to-Roller Attachment: Manufacturer's standard method.

C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Design to withstand dead weight and operating stresses; provide brackets at both ends. Shadebands:

1. Shadeband Material: Room-darkening fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
3. Type: Enclosed in sealed pocket of shadeband material.

D. Installation Accessories:

1. Fascia: Removable extruded aluminum fascia, size as required to conceal shade mounting, attachable to brackets without exposed fasteners.

   a. Finish: Fabric wrapped to match shade.
   b. Can be installed across two or more shade bands in one piece.

2. Single Fascia: Accommodate regular roll shades.

3. Profile: Square.

4. Configuration: Continuous, fascia extends past continuous bracket

5. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering (Translucent) Fabric: Dim-Out shade; woven fabric, stain and fade resistant.

1. Source: Roller-Shade Manufacturer.
2. Type: 100-percent Woven Fiberglass
3. Roll Width: 76 in
4. Orientation on Shadeband: Railroaded.
5. Openness Factor = 1- percent
6. Solar Transmittance = 16
7. Solar Reflectance = 36
8. Solar Absorptance = 48
9. Visual Transmittance = 15
10. Color: Lutron Classico Collection, Translucent Fabrics; Translucent P: Chartreux PF-608-1 (BASIS OF DESIGN)

2.4 ROLLER-SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.

C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:

1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4 provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.

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

3.2 ROLLER-SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Final Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Final Completion.

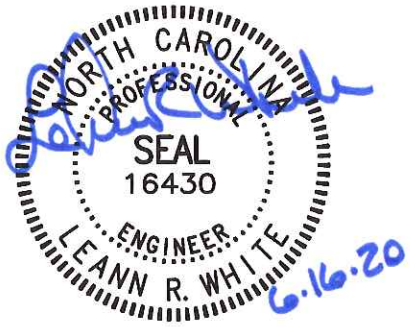
END OF SECTION 122413

CAPE FEAR COMMUNITY COLLEGE
NORTH CAMPUS NE BLDG LAB UPFIT
CASTLE HAYNE, NORTH CAROLINA

SECTION 230210 – HVAC SUMMARY OF WORK

Heating, Ventilating, and Air-Conditioning work shall be defined by drawings numbered with the prefix "H", the general provisions of the Contract including General Conditions and Supplementary Conditions, Division 1 Specification sections, and Division 23 Technical Specification sections listed below. In addition, Heating, Ventilating, and Air-Conditioning work may be defined by reference to other documents by any of the above-named sources as well as by project addenda.

Engineer of Record for Heating, Ventilating, and Air-Conditioning work is LeAnn R. White, PE, Stanford White, Inc., 1620 Midtown Place (27609), P. O. Box 19944, Raleigh, NC 27619.



DIVISION 23 - HVAC TECHNICAL SPECIFICATIONS

Section	Title
230210	HVAC Summary of Work
230510	HVAC Basic Requirements
230511	Electrical Provisions for HVAC Work
230521	HVAC Piping Specialties
230523	HVAC General-Duty Valves for Hydronic Piping
230529	Hangers and Supports for Piping, Ductwork & Equipment
230548	HVAC Vibration Control
230553	HVAC Painting and Identification
230555	HVAC Pipe Flushing, Testing, and Cleaning
230593	HVAC Testing, Adjusting, and Balancing
230596	HVAC Systems Verification
230713	HVAC Duct Insulation
230719	HVAC Piping Insulation
230913	Instrumentation and Control Devices for HVAC
230923	Extension of Existing Direct Digital Control Systems for HVAC
233100	HVAC Ductwork
233300	Air Duct Accessories
233600	Air Terminal Units
233713	Diffusers, Registers, and Grilles

END OF SECTION 230210

SECTION 230510 – HVAC BASIC REQUIREMENTS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

The requirements specified herein shall govern all Sections in Division 23, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Submit Welder's and Brazer's Qualifications in accordance with Section 019913. Welders' and Brazers' Qualifications: Operators who are to do the welding and/or brazing must be properly qualified to do satisfactory work. **Proof of an operator's qualifications shall be either the Contractor's record of suitable tests passed within the preceding six months while in the employ of the Contractor, or tests made before the start of work.** Submit qualification data for each operator prior to their starting work. Any workman considered by the A-E as not having the skill necessary for the work shall be required to pass an appropriate qualification test or shall be at once barred from further welding and/or brazing on the project.

TEMPERATURE AND HUMIDITY CRITERIA

Indoor temperature and humidity conditions in occupied spaces, unless specifically specified or indicated otherwise on the Drawings, shall be maintained as follows:

Space/ Area	Indoor Air Condition	Occupied Periods	Unoccupied Periods
General occupied spaces	Dry Bulb Temperature	70-77 deg F	55 deg F, Minimum 85 deg F, Maximum
	Relative Humidity	30-60% RH	65% RH Maximum

ACOUSTIC CRITERIA

Noise levels due to HVAC equipment, ducts, grilles, registers, diffusers, etc., shall result in maximum sound levels in occupied spaces conforming to the following Room Criteria (RC):

Max. RC	Environment	Typical Occupancy
25	Extremely quiet environment, suppressed speech is audible, suitable for acute pickup of all sounds.	Broadcast or recording studios, concert halls, music rooms, bedrooms, special classrooms for the very young or hearing impaired, etc.
30	Very quiet, suitable for large conferences; telephone use satisfactory; sleeping unimpaired.	Residences, hotel or hospital sleeping rooms, theaters, auditoriums, libraries, executive offices, directors' rooms, large conference rooms, etc.
35	Quiet, suitable for conference at 15 ft. table; normal voice 10-30 feet; telephone use satisfactory.	Private offices, school cafeterias, court rooms, churches, small conference rooms, etc.

40	Satisfactory for conferences at 6-8 ft. table; normal voice 6-12 ft.; telephone use satisfactory	General (open) offices, school corridors, laboratories, restaurants, etc.
45	Satisfactory for conferences at 4-5 ft. table; normal voice 3-6 ft., raised voice 6-12 ft; telephone use is somewhat difficult.	Retail stores, cafeterias and fast food dining, lobbies or public areas, etc.
50	Unsatisfactory for conferences; normal voice 1-2 ft., raised voice 3-6 ft.; telephone use is difficult.	Workshops, machine rooms, industrial process areas, etc.

For classrooms for primary education, colleges and universities, training facilities, etc., HVAC systems and their components shall be selected/installed to comply with ANSI Standard S12.60.

VIBRATION CRITERIA

Unless indicated otherwise on the Drawings for building areas, vibration transfer to the building structure in each octave band, directly or indirectly, from HVAC equipment shall be limited to comply with the following, where "curve" indicates the applicable vibration criteria curve shown in Fig. 41, Chapter 48, *2007 ASHRAE Handbook, HVAC Applications*:

Occupancy Type	Curve
Workshops, machine rooms, industrial process areas, etc.	Workshop
Retail stores, commercial cafeterias and fast food dining, lobby or public areas, general (open) offices, school corridors, restaurant and entertainment facilities, etc.	Office
Private offices, school cafeterias, court rooms, churches, conference rooms, residences, general classrooms, theaters, libraries, executive offices, directors' rooms, hospital patient care areas, etc.	Residential, Night
Hospital operating rooms and critical care areas, etc.	Operating Room
Research laboratories, etc.	VC-A, Research Laboratory
Vibration sensitive equipment or procedure areas	VC-A through VC-E, as indicated on the Drawings

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

PIPING BRAZING/SOLDERING

Low Pressure Piping (Below 15 Psig): Low pressure piping systems shall be fabricated, assembled and welded/brazed/ soldered in accordance with the ASME B31.1.

OPERATION OF HVAC SYSTEMS

The use of permanent HVAC systems to support general construction activities is prohibited. The need for heating, cooling, dehumidification, and/or ventilation during construction by the General Contractor or any project sub-contractor shall be met via use of temporary HVAC units or systems, as specified in Division 01, provided by the contractor(s) having the need.

HVAC equipment, subsystems, and/or systems may be started and temporarily operated as necessary to perform the work, testing, balancing, and/or verification as specified in various sections of Division 23. Air systems shall be started **only** after general construction activities in the areas served by the air systems are such that there is low risk of contamination and/or degradation to the system. Generally, the following construction status is required within the entire area served by an individual air system:

Floor/wall/ceiling preparation that requires sanding or other dust producing work is complete.

Wall/ceiling surfaces required to be painted shall at least have one coat of primer applied.

Ceiling spray-on decorative or acoustical coatings, where specified, are complete.

Lay-in ceilings, where specified, have been installed.

Floors finishes (tile, carpet, paint, etc.) shall be complete.

Dust-producing outdoor (site) work has been completed.

During temporary operation of air systems, the following additional measures are required:

Filters shall be installed in fan coil units, air handling units, etc.

Install temporary roll media filters (minimum MERV 13) over each air inlet (return or exhaust). Temporary filters shall be replaced regularly in order to minimize pressure losses impose on fans.

Windings of open, drip proof electric motors shall be cleaned using low pressure compressed air at the end of each 72 hours of operation.

Once HVAC systems verification/commissioning has been completed, air systems shall be shut down, temporary filters removed, and air handler filters replaced with new unless specifically directed otherwise by the A-E. **Only upon receipt of written approval by the A-E shall HVAC systems be placed into final service for Substantial Completion of the Project.**

END OF SECTION 230510

SECTION 230511 - ELECTRICAL PROVISIONS FOR HVAC WORK

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

The requirements specified herein shall govern all Sections in Division 23, whether stated therein or not.

Where items specified in the other sections of this Division conflict with requirements of this Section, the former shall govern.

DESCRIPTION OF WORK

Work includes, but is not necessarily limited to the following:

Provide electrical heating coils and similar elements in mechanical equipment.

Provide motor starters for furnished equipment where starters are required for the intended application when **not provided under Division 26**. Starters shall be sized in accordance with the latest edition of the National Equipment Manufacturers Association (NEMA) standard ratings for magnetic starters, and the *National Electrical Code* (NEC).

NEMA Starter Sizes for Motors					
NEMA Starter Size	Maximum HP for System Voltage (V)/ Phase (PH)				
	120V/1PH	240V/1PH	208V/3PH	240V/3PH	480V/3PH
00	1/3	1	1-1/2	1-1/2	2
0	1	2	3	3	5
1	2	3	7-1/2	7-1/2	10
2	3	7-1/2	10	15	25
3	7-1/2	15	25	30	50
4	-	-	40	50	100

Provide disconnect switches for all furnished equipment. Disconnect switches shall be sized in accordance with the latest edition of the NEC for single motor applications as follows:

Disconnect Switch Sizes for Motors						
Switch Rating Amps (A)	Maximum HP at System Voltage (V))/ Phase (PH)					
	120V/1PH	208V/1PH	240V/1PH	208V/3PH	240V/3PH	480V/3PH
30A	1-1/2	3	3	5	7-1/2	15
60A	3	7-1/2	10	15	15	30
100A	5	10	10	25	25	60
200A	-	-	-	50	60	100
400A	-	-	-	100	125	250
600A	-	-	-	150	200	400

Disconnect switches shall be sized for all other applications based on total kW rating of the equipment as follows:

Disconnect Switch Sizes for Equipment							
Switch Rating Amps (A)	Maximum kW at System Voltage (V)/ Phase (PH)						
	120V/ 1PH	208V/ 1PH	240V/ 1PH	277V/ 1PH	208V/ 3PH	240V/ 3PH	480V/ 3PH
30A	2.8	5.0	5.8	6.6	8.6	10.0	19.9
60A	5.8	10.0	11.5	13.3	17.3	19.9	39.9
100A	9.6	16.6	19.2	22.2	28.8	33.2	66.4
200A	19.2	33.3	38.4	44.3	57.6	66.4	132.9
400A	38.4	66.6	76.8	88.6	115.1	132.9	265.7
600A	57.6	99.8	115.2	133.0	172.7	199.3	398.6

Dual element fuses shall be provided with disconnect switches. Fuses shall be sized based on the nameplate rating for the equipment.

Equipment enclosures for disconnect switches, starters, variable frequency drives, control panels and any other panel enclosures housing electrical equipment shall be rated based on NEMA standard ratings. Panel enclosures shall be suitable for the environment in which they will be installed. Unless noted otherwise, provide NEMA rated enclosures based on the following environment conditions:

NEMA Enclosure Ratings for Electrical Equipment	
NEMA Type	Environment Condition
1	Indoors only, dry, low dust, and non-corrosive environment
3R	Outdoors, weatherproof and rainproof
4	Outdoors, watertight and raintight
4X	Same as 4 plus corrosion resistant
7	Hazardous locations Class I, Groups A, B, C, or D
9	Hazardous locations Class II, Groups E, F, or G
12	Indoors subject to circulating non-hazardous dust, or dripping non-corrosive liquids

Provide all single phase interlock and control wiring required for sequenced operation of mechanical devices provided for mechanical systems under Division 23. Under Divisions 26-28, a source of power for these devices shall be provided and extended to the devices under Division 23.

Make all power wiring connections for mechanical equipment as recommended by the equipment manufacturer. Under Divisions 26-28, power wiring to the line side of a disconnecting provided and installed under Division 23 will be provided.

> Some items of equipment may require conductor and/or raceway combinations different from the supply conductors provided under Division 26-29 to the equipment disconnect; coordinate and provide connections as recommended by the equipment manufacturer.

Division 23 Contractor is responsible for providing and installing fuses in disconnects that supply Division 23 utilization equipment.

Provide any required power wiring not specifically shown on the electrical drawings (E-Sheets) or specified in Divisions 26-28.

QUALITY ASSURANCE

Coordination with Electrical Work: Wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in Divisions 26-28 sections. Comply with requirements of applicable Divisions 26-28 sections for raceways and wiring methods associated with final electrical connections to equipment installed under this Division.

Standards:

For electrical equipment and products, comply with applicable NEMA standards and refer to NEMA standards for definitions of terminology herein.

Comply with NFPA 70, *National Electrical Code* (NEC) for workmanship and installation requirements.

Comply with NFPA 70E, *Standard for Electrical Safety in the Workplace*, while performing any electrical work. **(NFPA 70E is referenced in OSHA 29CFR Part 1910, Subpart S, Appendix A, and is considered by OSHA as the industry practice for electrical safety.)**

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for electrical materials and products.

Source Limitations: Provide motor starters, combination motor starters, and disconnects through one source from a single manufacturer.

PART 2 - PRODUCTS

MOTOR STARTERS

Motor Starters: Provide surface-mounted, heavy duty, steel enclosed motor starters with NEMA size rating, voltage rating, current rating, and number of poles indicated on the Drawings.

Motor starters with no drawing indication of number of poles are three pole types. Starters shall be rated as follows unless otherwise specified:

For 480Y/277 V.: Use 600 volt type

For 208Y/120 V.: Use 250 volt type

For 120/240 V.: Use 250 Volt type

Provide full voltage, non-reversing magnetic motor starters with auxiliary control devices as indicated.

Provide units with RMS symmetrical fault withstand rating suitable for application, but no less than 22,000 amps. Design of units shall ensure that faults will be contained within the starter enclosure.

Running Overload Protection: Equip with thermal overload protection// device for each motor circuit.

Auxiliary Contacts: Provide two sets of normally open auxiliary contacts and two sets of normally closed auxiliary contacts.

Provide additional **sets** of normally open and/or normally closed auxiliary contacts is such are required to accomplish control functions as defined by the drawings or required by specified control and interlock sequence(s).

Provide additional sets of contacts as required to operate pilot lights as described elsewhere. Contacts required to operate pilot lights are **not shown on the Drawings**. Contacts required to operate pilot lights are to be furnished at no additional cost.

Accessories on Cover: Provide the following accessories on the combination starter cover.

Reset Pushbutton

Hand-Off-Automatic (HOA) Switch

Push to Start Switch

Pilot Lights on Cover: Pilot lights are to be transformer types, configured to operate from the same voltage as the motor starter coil. Provide the following pilot lights on the starter cover.

Red Pilot Light, illuminated when starter is energized

Green Pilot Light, illuminated when starter is not energized

Disconnect Auxiliary Contacts: Provide 2 pole disconnect auxiliary contacts for control circuits where control circuits are provided from a separate electrical source.

Coils: Provide starters with operating coils for 120 volts.

Control Transformer: Where indicated on the Drawings, provide control transformer having a primary voltage rating to match the line-to-line voltage of the motor supplied by the starter and a secondary voltage to match the voltage of the starter coil. Size control transformer to supply the starter and all pilot devices supplied with a 25% reserve capacity for additional pilot devices.

Provide NEMA-rated enclosure type suitable for its environment as required by Section 230511.

COMBINATION MOTOR STARTERS

General: Combination starters may be used in lieu of separate disconnect and motor starter. Provide surface-mounted, heavy duty, steel enclosed combination motor starters meeting requirements described for motor starters. Provide combination motor starters with NEMA size rating, voltage rating, current rating, and number of poles indicated on the Drawings.

Circuit Breakers: Provide factory-assembled, molded-case circuit breakers with permanent instantaneous magnetic trips in each pole, with fault-current interrupting rating suitable for application and ampere ratings as indicated. Circuit breaker ratings must be clearly visible when the compartment door is open without the necessity of removing operating mechanisms or similar items to obtain visibility. Where adjustable circuit breakers are provided, such adjustments must be also be readily accessible once the compartment door is opened. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in ambient temperature of 40° C. Provide with AL/CU rated screw type removable connector lugs. Field coordinate all circuit breaker sizes with equipment nameplate ratings prior to purchase.

Disconnect Operators: Provide external operator handles for circuit breakers. Design handle with up-down motion and with down position indicating “OFF." Combination Motor Starters with rotary type circuit breaker operators are not acceptable. Construct handles which permit locking handle in “ON” or “OFF” position with a hasp-type padlock.

Provide two-pole interlock switches for all disconnects that are used with utilization equipment requiring control connections provided from separate electrical sources. The interlock switch is to be configured such that when the disconnect is open the interlock switch is open.

Provide additional interlock switches, auxiliary contacts, plumbing key interlocks, or other accessories as may described by the Drawings.

Provide NEMA-rated enclosure type suitable for its environment as required by Section 230511.

CIRCUIT AND MOTOR DISCONNECTS

Safety Switches: Provide surface-mounted, heavy duty, steel enclosed safety switches, of types, voltage rating, current rating, and number of poles indicated in this Section.

Switches with no drawing indication of number of poles are three pole types. Switches shall be fusible type, rated as follows unless otherwise specified:

For 480Y/277 V.: Use 600 Volt type, with neutral and grounding bus.

For 208Y/120 V.: Use 250 Volt type, with neutral and grounding bus.

For 120/240 V.: Use 250 Volt type, with neutral and grounding bus.

Where a neutral is not provided to the specific utilization equipment served, the neutral bus can be bonded to the enclosure and used as a grounding bus.

Provide horsepower rated switches incorporating quick-make, quick-break type switches constructed so that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable. Internal current carrying components shall be high-conductivity copper; switch contacts shall be silver-tungsten type. Fuse holders shall have positive pressure type reinforced fuse clips. Where non-fused disconnect switches are indicated, provide solid copper bus bars in lieu of fuses.

Provide NEMA-rated enclosure type suitable for its environment as required by Section 230511.

Provide switches that may be locked in either the “ON’ or ‘OFF’ condition with a 1/4" shackle hasp-type lock. Safety switches shall have door interlocks that prevent the door from opening when the operating handle of the switch is in the “on” position. Manual defeat mechanisms shall be provided for the interlocks.

Provide two-pole interlock switches for all disconnects that are used with utilization equipment requiring control connections provided from an alternate power source. The interlock switch is to be configured such that when the disconnect is open the interlock switch is open.

Provide additional interlock switches, auxiliary contacts, mechanical key interlocks, or other accessories as described by the Drawings.

Fuses shall be furnished by the Contractor. Fuses shall be current limiting type with a minimum AIC rating of 100,000 AMP. The contractor shall furnish Owner with one complete set of spare fuses at the completion of the project.

PART 3 - EXECUTION

GENERAL

Coordinate the exact location of all equipment disconnects to ensure that disconnects are located within sight of mechanical equipment.

Extend power wiring circuits from load side of termination points provided under Divisions 26-28 to each item of mechanical equipment requiring electrical power. All wiring shall be installed in raceway in compliance with Division 26. Utilize liquid tight flexible metallic conduit for weatherproof for outdoor locations. Provide all necessary clamps, fitting, connectors, raceways, circuit conductors, etc., for a completely operational system.

INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS

Install disconnects as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

Coordinate placement of disconnects with electrical raceway and cable work, as necessary for proper interface. Coordinate exact location of disconnects with equipment electrical connection point.

> Locate disconnects so that they are readily accessible after all project elements are installed. Location selected for disconnects must permit complete opening of the door or cover to the maximum amount permitted by the design of the switch enclosure.

Install disconnects for use with motor-driven appliances and motors within sight of the controllers, as indicated on the Drawings. In addition, each motor shall be provided with an approved disconnecting device within sight of the respective equipment as required by the NEC even though not specifically indicated on the Drawings. Disconnects installed for use with controllers may serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

INSTALLATION OF STARTERS

Install starters as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

Coordinate placement of starters with electrical raceway and cable work, as necessary for proper interface. Coordinate exact location of starters with equipment electrical connection point.

> Locate starters so that they are readily accessible after all project elements are installed. Location selected for starters must permit complete opening of the door or cover to the maximum amount permitted by the design of the switch enclosure.

GROUNDING

Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for electrical combination motor starters. All combination starters shall be grounded by means of a separate insulated grounding conductor, run with the ungrounded conductors, and bonded to the starter enclosure by means of a dedicated grounding screw terminal or bus.

FIELD QUALITY CONTROL

Subsequent to completion of installation of disconnects and motor starters, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230511

SECTION 230521 – HVAC PIPING SPECIALTIES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty.

PART 2 - PRODUCTS

DIELECTRIC FITTINGS

Dielectric Unions: Steel female pipe thread and copper solder joint ends conforming to dimensional, strength, and pressure requirements of ASME B 16.39, Class 1. Steel parts shall be galvanized or plated. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, it shall also be able to withstand a 600-volt breakdown test.

Dielectric Flanges: Factory-fabricated companion-flange assembly rated for 150 psig or 300-psig as required by system operating pressure. Include flanges, full-face or ring-type neoprene or phenolic gasket, phenolic or polyethylene bold sleeves, phenolic washers, and steel bolts, backing washers, and nuts.

INSERTION TEST PLUGS ("Pete's Plugs")

Provide insertion test plugs pressure rated for 500 psi and 200 deg. F as indicated on the drawings. Construct of brass and finish in nickel-plate equip with 1/2" NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gage or thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

FLEXIBLE PIPING CONNECTORS

Flexible connectors shall be designed for no less than 125 psi pressure and have a maximum operating temperature of 250 deg F. Each unit shall be of the proper length to accept the movement involved.

Connectors shall be neoprene-based of single- or double-sphere molded joint configuration and shall meet or exceed specifications of the Rubber Expansion Joint Division, Fluid Sealing Association.

Connectors shall be fabricated of molded EPDM, reinforced with nylon tire cord and shall have steel floating flanges or female union ends, as required to match adjacent piping.

PART 3 - EXECUTION

INSTALLATION OF PIPING SPECIALTIES

Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

Flexible Piping Connectors: Install flexible connectors in piping connected to equipment mounted on vibration isolators to allow for movement between pipe and equipment. Locate flexible connector, where ever possible, in vertical piping, as close as possible to an anchor point. **Ensure that no piping load is supported by the connector**. Piping on either end of connector shall be aligned within 1/8 inch. Do not install flexible connector until all nearby welding is completed.

INSTALLATION OF TEMPERATURE GAGES

General: Install temperature gages in vertical upright position, and tilted so as to be easily read by observer standing on floor.

Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

ADJUSTING AND CLEANING

Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230521

SECTION 230523 – HVAC GENERAL-DUTY VALVES FOR HYDRONIC PIPING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

ANSI/MSS Compliance: Valves shall comply with Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (ANSI/MSS) standards as referenced hereinafter. Mark valves in accordance with MSS 25.

ASME Compliance:

ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

ASME B31.9 for building services piping valves.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of valve.

PART 2 - PRODUCTS

GENERAL

Valve Types: Provide valves of same type, provided by same manufacturer throughout.

Sizes: Unless otherwise indicated on the Drawings, provide valves of same size as upstream pipe size.

Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6" and smaller, other than plug valves. Where quarter turn valves are used for balancing purposes, provide memory stops.

HVAC WATER SYSTEMS VALVES

General: Water systems valves shall be rated at not less than 125 psig WOG at 240-deg. F.

Valves 2" NPS and smaller: Provide with screw or solder ends to match piping.

Ball Valves: Valves shall be rated 600 psi non-shock CWP and will have 2-piece cast bronze bodies, TFE seats, full port, separate packnut with adjustable stem packing, anti-blowout stems and chrome-plated brass/bronze ball, and be manufactured to comply with MSS SP110.

Calibrated Balancing Valves: Valves shall be suitable for 200 psi non-shock CWP at 240-deg F, with bronze or copper alloy body and calibrated ball, globe, or venturi configuration for flow control. Valve shall have integral pointer and calibrated scale to register degree of valve opening, memory stop, drain tapping, and be equipped with pressure taps for differential pressure measurement with integral check valves and seals. Valves shall be Armstrong "CBV", Bell & Gossett "Circuit Setter Plus", Griswold "Quickset", or Taco "Accu-Flo". **Provide differential pressure vs. flow calibration chart for use by TAB sub-contractor.**

Automatic Balancing Valves: Valves shall maintain constant flow, plus or minus 5 percent, over the full range of system pressure fluctuations. Provide ASTM B584 brass body with screwed ends rated for CWP of 300 psig and maximum operating temperature of 250 deg F. Internal flow control mechanism shall consist of one-piece cartridge with segmented port design and full travel linear coil spring. Cartridge and spring shall be stainless steel, tamper proof, self cleaning, and removable. Select valve to match adjacent pipe size, 3/4"-3" NPS. Select each valve for specific flow capacity indicated on the Drawings and tag the valve with a permanent marker identifying the service, AHU or coil number, valve number, and flow rate. Replace cartridges, up to 10% of total quantity of valves, without charge due to capacity changes.

PART 3 - EXECUTION

VALVE APPLICATION

Shut-off and isolation valves 2" and smaller may be ball valves.

Drain valves shall be 3/4" ball valves with a threaded hose adaptor and cap with chain.

Blowdown valves from Y-strainers shall be ball valves, full size of blowdown connection.

VALVE INSTALLATION

Except as otherwise indicated, comply with the following requirements:

Install valves where required for proper operation of piping and equipment, **including valves in branch lines to isolate sections of piping**. Locate valves so as to be accessible and so that separate support can be provided when necessary.

Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

Install calibrated balancing valves or automatic flow control valves at water coils as indicated on the Drawings.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS FOR PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc. Standard Compliance: Comply with MSS SP-58 *Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation* for pipe hangers and supports.

SMACNA Compliance: Fabricate and install ductwork hangers and supports in accordance with *HVAC Duct Construction Standards - Metal and Flexible*.

ASTM Compliance: Structural steel elements utilized for piping, ductwork, or equipment support shall comply with ASTM A 36.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.

PART 2 - PRODUCTS

GENERAL

Hangers and supports for HVAC piping, ductwork, and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

Design supports for multiple pipes and/or ducts, including floor stands, to be capable of supporting combined weight of supported systems and system contents.

Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

Structural support elements shall be fabricated from standard structural shapes complying with ASTM A 36 and/or from preformed channel struts.

Preformed channel struts shall be 1-5/8 inches wide by height required to meet load capacities and designs indicated on the drawings. Strut shall be made from steel meeting the minimum mechanical properties of ASTM A653 SS, Grade 33, G90 galvanized. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633, SC3 for fittings and SC1 for threaded hardware. Channel members shall be "Unistrut", Allied Support Systems "Power Strut", or Cooper B-Line Systems, Inc. "Strut System", specifically sized in accordance with the criteria hereinbefore specified.

Building attachments for hangers and supports shall be as indicated on the Drawings. Where attachments are not indicated, they shall be as follows:

Attachment To	Attachment Method(s)
Concrete	Bolt to channel-type concrete inserts or utilize expansion anchors. Size concrete housekeeping pads so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base. Drill at locations and to depths that avoid reinforcing bars.
Solid Concrete Masonry Unit Walls	Use expansion anchors.
Hollow Walls	Bolt to slotted steel channels fastened to wall with expansion anchors.
Wood Structural Members	Install bolts through members.
Steel	Bolt hangers to MSS Type 19, 21, or 23 clamps on flanges of beams or on upper truss chords of bar joists. **To avoid stressing building steel structural elements, provide additional steel support members that span at least two beams or bar joists as required or as shown on the Drawings.** Attach additional steel support members via welding in accordance with AWS standards.

PIPE HANGERS AND SUPPORTS

General: Piping systems shall be classified in accordance with MSS SP-58, as follows:

Classification	Temperature Range (deg F)	Typical Service Applications
Type 1: Hot Systems	Type 1A: 120-250	Hot Water

Horizontal Pipe Hangers: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers complying with MSS SP-58, of the following MSS types listed, to suit horizontal-piping systems:

Adjustable Steel Clevis Hangers: MSS Type 1 for Classification.

Split Ring Hanger: MSS Type 69, 2" NPS and smaller.

Copper Pipe Hangers: Copper-plated or -coated steel.

Insulation Protection: Provide MSS Type 39 pipe saddle for Classification Type 1B piping and MSS Type 40 insulation shield at each pipe support.

Vertical Piping: Provide factory-fabricated riser clamps complying with MSS Type 8 to support vertical piping systems. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.

DUCT HANGERS AND SUPPORTS

Ductwork hangers shall be fabricated of sheet metal straps (round duct only) in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible* or of all-thread rod.

EQUIPMENT HANGERS AND SUPPORTS

Suspended Equipment: For suspended equipment, the Contractor shall provide structural steel framing to distribute the imposed operating loads without stressing building structural elements or causing damage to the building substrate. Weld steel in accordance with AWS standards.

PART 3 - EXECUTION

INSTALLATION OF PIPE HANGERS AND SUPPORTS

Use only one hanger type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation for insulated piping.

Arrange for grouping of parallel runs of horizontal suspended piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings and all-thread hanger rods sized in accordance with the following:

Nominal Pipe Size (in.)	Max. Span for Copper Tubing (ft.)	Max. Span for Steel Pipe (ft.)	Min. All-Thread Hanger Rod Size (in.)
<1	5	7	3/8
1 to 1-1/4	6	7	3/8
1-1/2	8	9	3/8
2	8	10	3/8

Hangers and supports for piping shall be attached to the building structure; **attachment to roof deck or cross-bracing is prohibited; attachment to other piping, ductwork, or equipment is prohibited. The use of wire or perforated strap hangers is prohibited.**

INSTALLATION OF DUCT HANGERS AND SUPPORTS

Hang or support metal ductwork in accordance with Section 5 of SMACNA's *HVAC Duct Construction Standards - Metal and Flexible* except no straps on rectangular ductwork. Where multiple ducts are supported by a common trapeze hanger, the trapeze shall comply with Table 5-3.

Suspend flexible ducts in accordance with SMACNA's HVAC *Duct Construction Standards - Metal and Flexible*, Figures 3-10 and 3-11.

Hangers and supports for ductwork shall be attached to the building structure; **attachment to roof deck or cross-bracing is prohibited; attachment to other ductwork, piping, or equipment is prohibited. The use of wire or perforated strap hangers is prohibited.**

Support metal duct risers with structural channels or angles at each floor. Attach structural members to the sides of the ducts with welds, bolts, of sheet metal screws.

INSTALLATION OF EQUIPMENT HANGERS AND SUPPORTS

Suspended equipment shall be supported by structural steel members or preformed channel struts with all-thread rod hangers. As required, vibration isolations required by Section 230548 shall be installed between the supports and the hangers. Suspended units shall be installed level and plumb.

Hangers and supports for equipment shall be attached to the building structure; **attachment to roof deck or cross-bracing is prohibited; attachment to ductwork, or piping is prohibited. The use of wire or perforated strap hangers is prohibited.**

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230529

SECTION 230548 – HVAC VIBRATION CONTROL

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

DEFINITIONS

Vibration Control: A fixed device used to prevent or reduce the transmission of vibration created by mechanical equipment.

Isolation Efficiency: The percentage of vibration force transmitted to the support structure. For example, 90% efficiency results in 10% of the vibration force being transmitted.

Internal Isolation: Vibration isolators that isolate only the moving parts of a piece of equipment.

External Isolation: Vibration isolators that are attached directly to the building structure and isolate the entire piece of equipment.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Product Data: Illustrate and indicate types, styles, materials, strength, fastening provisions, and finish for each type and size of vibration isolation component used.

DESIGN CRITERIA AND PERFORMANCE REQUIREMENTS

Delegated Design: **Responsibility for the selection and application of vibration isolation elements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria hereinafter specified, is delegated to the Contractor.** The professional engineer performing delegated design shall sign and seal any drawings, calculations, product selections, etc. and submit the these documents to the A/E for review.

Performance Requirements and Design Criteria: Motor-driven equipment shall be isolated from the structure by means of resilient vibration and noise isolating supports to achieve the vibration limits imposed in Section 230510.

Supports shall be such that vibration is isolated and expansion and contraction is accommodated without creating excessive stresses in piping or equipment connections.

Isolator types and vibration bases shall be selected and sized for each equipment item in accordance with manufacturer's recommendations and in compliance with Table 47, Chapter 48, 2011 ASHRAE Handbook-*HVAC Applications*.

Examine areas and conditions under which vibration control is to be installed and the substrates that will support same. Notify A/E in writing of conditions detrimental to proper completion of the Work. Do not proceed with the Work until satisfactory conditions have been met.

Coordinate layout and installation of vibration controls with building structural system, architectural features, mechanical, electrical and fire suppression systems and other building features. Coordinate the equipment bases with the building structural system.

Comply with additional criteria and specific requirements defined in Part 2 of this Section.

PART 2 – PRODUCTS

VIBRATION ISOLATION

Corrosion Resistance: Isolators shall be designed and/or treated for resistance to corrosion, as follows:

Steel components shall be hot-dipped galvanized, PVC coated, or primer coated and painted with finish coat of industrial grade enamel.

All nuts, bolts and washers shall be hot-dipped galvanized or stainless steel.

Structural steel vibration bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer and a finish coat of industrial enamel applied over the primer.

Isolators exposed to the weather shall have steel parts PVC coated, hot-dipped galvanized, or zinc-electroplated, with an additional coating of neoprene or bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel. Nuts, bolts and washers shall be stainless steel.

Deflection: Isolators shall be installed in such a manner that loaded deflections are compensated for initially.

Isolator Elements: Steel springs shall be open or housed type as specified with static deflection required and the capability of 30% overtravel before becoming solid. Springs shall be designed for lateral stability with a stiffness ratio of 1 except where greater horizontal thrust required greater horizontal stiffness.

Elastomers shall be rubber, neoprene, Buna N, silicone or other material to meet specific service conditions and shall be molded in the range of 30 to 60 durometer. Material shall be of color coded stock for easy identification of rated load capacity.

Precompressed fiber glass shall consist of a high density matrix of molded glass fiber encased in a waterproof neoprene jacket resistant to oil, acids and fungus and color coded for easy identification of rated load capacity.

Isolator Types: Isolators shall be applied in accordance with the "types," as follows:

Type I - Pad type mountings consisting of any one of the following constructions:

Two layers of ribbed or waffled neoprene pads bonded to a 16 gauge galvanized steel separator plate. Bolting not required. Pads shall be sized for approximately 20 to 40 psi load, or a deflection of 0.12 inch to 0.16 inch.

Precompressed fiberglass properly sized for 5 to 60 psi loading depending on density with steel plates bonded to top of isolator.

Two layers of ribbed or waffled neoprene pads bonded to vibration cork sized for 10 to 60 psi loading.

Type II - Elastomeric mountings having steel baseplate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric material. Mountings shall be designed for approximately 1/4 inch deflection and loaded so that deflection does not exceed 15% of the free height of the mounting.

Type III - Adjustable, freestanding, open-spring mountings with combination leveling bolt and equipment fastening bolt. Spring (or springs) shall be rigidly attached to mounting baseplate and to the spring compression plate. A neoprene pad having a minimum thickness of 1/4 inch shall be bonded to the baseplate.

Type IV - Spring hangers consisting of a rectangular steel box, elastomeric element, coil spring, spring cups, neoprene impregnated fabric washer, and steel washer. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the top of the hanger box. The elastomeric element shall meet the design requirements for Type II mountings. The hanger box shall be capable of supporting a load of 200% of rated load without noticeable deformation or failure.

Piping Vibration Isolation: Flexible connectors in accordance with Section 230521 shall be installed at each pipe connection to equipment mounted on vibration isolators.

Duct Vibration Isolation: Flexible connectors in accordance with Section 233300 shall be incorporated in ductwork where connected to air moving units.

PART 3 - EXECUTION

GENERAL

Installation of vibration controls shall be in accordance with manufacturer's recommendations and building construction standards. Whenever a conflict occurs between the manufacturer or construction standards, the more stringent shall apply.

MECHANICAL EQUIPMENT ANCHORAGE

Anchor equipment or equipment bases rigidly to the building structure or to a concrete housekeeping pad in accordance with Section 019913. Anchors, hanger rods, etc. shall not interfere with the required performance of isolator elements.

Where equipment with internal vibration isolation is determined by the A/E to need additional external isolation, the internal isolators shall be neutralized by bolting the isolators down or removing them and new external isolators shall be installed. Coordinate this with the equipment manufacturer for best methods.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230548

SECTION 230553 - HVAC PAINTING AND IDENTIFICATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions.

PART 2 - PRODUCTS

PAINT FOR HVAC

Ferrous Surfaces:

1 coat of fast drying, low VOC acrylic modified medium oil alkyd universal primer
2 coats of fast drying, low VOC alkyd gloss enamel

Fabric Covering Insulation:

1 coat glue sizing
1 coat primer/sealer
1 coat fast drying, low VOC alkyd gloss enamel

PLASTIC LABELS FOR EQUIPMENT

General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, minimum 2-1/2" X 3/4", 1/16" thick, engraved with engraver's standard letter style of black with white letter color, minimum 1/4" high, and punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

Fasteners: Self-tapping stainless steel screws.

Content for Equipment: Equipment's designation as show on Drawings or Owner's unique equipment number. Contractor shall determine requirements prior to fabricating labels.

PIPE LABELS

Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1, except as hereinafter specified. Provide full-band pipe markers, extending 360 degrees around pipe at each location, that attach without fasteners or adhesives.

Content: Provide minimum 1-1/2" high lettering to identify piping service using the same designations and abbreviations used on the Drawings. Include arrow indicating flow direction(s).

PART 3 - EXECUTION

PAINTING

Equipment specified in other sections of Division 23 to be provided with factory-applied finish painting shall not be field-painted. All finish painted equipment shall be touched up where factory paint is chipped, scratched, or otherwise damaged.

All equipment not factory finish painted shall be furnished in prime coat. All prime coated equipment shall be touched up where prime coats are chipped, scratched, or otherwise damaged. All prime coated equipment shall be thoroughly cleaned and left ready for finish painting.

All welds on both insulated and non-insulated piping shall be painted with one coat of primer. Miscellaneous black steel items such as hangers and rods, machinery supports, breechings and stacks, etc., that are not shop primed, shall be field painted with one coat of primer. All metal surfaces shall be thoroughly cleaned of rust and dirt and shall be degreased before application of primer.

Where cast iron accessories or galvanized pipe, duct, or equipment surfaces are to receive finish painting, the item shall be properly cleaned of mill residue before priming. Use primer specific to the application.

Finish painting of equipment, piping, ducts, plenums, casings, breechings, stacks, insulation, etc., located in mechanical equipment rooms and spaces where equipment, piping, etc. is exposed to view shall be provided. Where indicated or specified, existing equipment, piping, duct, etc., shall be cleaned and painted along with new work.

Exposed to view: Architect/Owner to select colors for finish painting.

HVAC IDENTIFICATION

Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

EQUIPMENT IDENTIFICATION

Install plastic equipment label on each terminal unit.

PIPING IDENTIFICATION

Provide pipe labels as follows wherever piping is exposed to view in finished spaces or concealed above lay-in ceilings.

Near major equipment items and other points of origination and termination.

Spaced at maximum spacing of 25' along each piping run.

CEILING IDENTIFICATION

For equipment located above an acoustical lay-in ceiling, provide a clear adhesive label on the ceiling grid directly below the equipment. The label shall indicate in black text the equipment designation (e.g., TU-#, AHU-#, etc.).

Provide blue colored adhesive 3/4" diameter vinyl “buttons” on the ceiling grid where valves, fire dampers, access doors, etc. are located above.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230553

SECTION 230555 – HVAC PIPE FLUSHING, TESTING AND CLEANING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

GENERAL

All new water systems shall be flushed and tested as hereinafter specified.

All temporary equipment and materials required to perform the tests and flushes shall be the responsibility of the Contractor.

Conduct flushing and pressure and leak tests prior to connection to any existing piping or new equipment.

If any change is made to the piping systems after testing and/or flushing has occurred, the affected portion shall be retested and flushed. If any portion of the piping system fails a test, it shall be retested. If any portion of the piping system is exposed to dirt or debris after flushing, it shall be reflushed.

PIPE FLUSHING

For above ground piping, prior to flushing, inspect the piping and run clean water thorough piping to remove all dirt and debris. Run clean water until the water draining from the pipe is clear and clean. Fill piping system with solution of clean water and 12% hypochlorite bleach (1 quart of bleach per 10,000 gallons of water for a residual concentration of 2-3 ppm chlorine), Nalco 2567 cleaner, or equivalent. Cleaner shall contain no trisodium phosphate. Circulate solution for at least 24 hours and then drain system to sanitary sewer.

Drain systems and fill with clean water for pressure and leak tests

PRESSURE AND LEAK TESTING

Prior to the start of the test, verify the maximum test pressure and duration with the pipe manufacturer. **Under no circumstances shall pipe be tested at pressures or durations that may cause damage to pipe or valves**.

Prior to pressurization, remove all air from the system. Provide vent taps at each high point in the system as needed to do so. During the pressure test, verify that no air pockets, defective materials, or leaking joints exist in the line.

Pressure test piping as follows:

> Test each section of hydronic piping at the highest point in the line. **Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design operating pressure**. Test pressure shall not exceed 125 psig or the maximum pressure rating for any vessel, pump, valve, or other component in system under test, whichever is lower.

Test each section of steam piping at the highest point in the line. **Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design operating pressure**. Test pressure shall not exceed 300 psig or the maximum pressure rating for any vessel, valve, or other component in system under test, whichever is lower. Verify that stress due to pressure does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.1.

Examine each section of piping for leaks in conjunction with the pressure test for a minimum of 2 hours.

CLEANING

Systems shall be cleaned after completion of flushing and testing.

Remove, clean, and replace strainer screens.

CERTIFICATION

Upon completion of flushing and testing of each pipe section, provide a letter to the A/E certifying that the tests and flushes were performed in accordance with the specification; what the final results were; what the intermediate results were; and what actions were taken to correct any leaks or problems. The letter shall be signed and dated by the Contractor's representative.

END OF SECTION 230555

SECTION 230593 – HVAC TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

DESCRIPTION OF WORK

Extent of testing, adjusting, and balancing (TAB) work is includes, but is not necessarily limited to, duct systems, piping systems, and associated equipment and apparatus of HVAC work.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Certification: Submit TAB subcontractor certification.

Instrument Calibration Report: Submit calibration test results for balancing instruments.

TAB Reports: Draft and final test reports

QUALITY CONTROL

TAB work shall be completed by an independent balancing subcontractor certified by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

Verification of HVAC systems requires participation by the TAB subcontractor as a member of the "Verification Team". See Section 230596 for requirements.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

GENERAL

After systems have been started up and initially adjusted, the Contractor shall perform tests and accomplish the balancing necessary to provide the air and water flows indicated on the Drawings.

TAB subcontractor shall spot check systems with A/E at Final Inspection.

CERTIFIED TEST REPORTS

General: Four copies of the Draft Test and Balance Reports shall be provided to the A/E before the Final Inspection. The reports shall comply with reporting procedures defined in Chapter 13, ASHRAE Standard 111 and as hereinafter specified.

After the A/E check of the system at or before the Final Inspection, the Final Test and Balance Reports shall be provided to the A/E. **Additionally, one copy of the Final Test and Balance Report shall be submitted to the authority having jurisdiction and a copy shall be included with each copy of the Operating and Maintenance Manuals.**

Certification: Both Draft and Final Reports shall be certified by the TAB subcontractor and shall:

Be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards.

Accurately represent how the systems have been installed.

Define how the systems are operating at completion of the TAB procedures.

Draft Reports: Upon completion of TAB procedures, prepare and submit draft reports for review by the A/E. Draft reports may be hand written, but must be complete, factual, and legible. Organize and format draft reports as hereinafter specified.

Final Reports: After review and verification by the field check by the A/E of the Draft Report, submit the Final Reports, organized and formatted as hereinafter specified.

Reports Format: Bind report forms complete with schematic systems diagrams and/or plans and other referenced data in reinforced, vinyl, three-ring binders.

Provide title page listing the name, address, and telephone numbers of the TAB subcontractor. Provide list of all test instruments utilized, along with last date of calibration.

Provide certification page, signed by the TAB project manager, as hereinbefore specified.

Divide contents of the binder into the following divisions, as applicable, separated by divider tabs:

General Information and Summary

Air Systems TAB

Hot Water Systems TAB

Reports Contents:

System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

Quantities of outdoor, supply, return, and exhaust airflows.

Water rates.

Pipe and control valve sizes and locations.

Flow and/or Flow Balancing stations.

Design Data and Test Results: For each HVAC component and system, provide design data and final adjusted test data, including but not limited to the following:

Component Data	Test Data (Design and Final Adjusted Values)
Duct Traverse	
Identification (referenced to system diagrams included in TAB reports) System, air-handling-unit, and/or fan identification	Location and zone. Traverse air temperature in deg F Duct static pressure in inches wg Duct size in inches Duct area in sq. ft. Air flow rate in cfm Air velocity in fpm
Air Terminal Device (Register, Grille, Diffuser, etc.)	
System and air-handling unit identification Room/area served Number from system diagram. Manufacturer Type and manufacturer's model number. Size (face and neck) Effective area in sq. ft.	Test method Design air flow rate in cfm Design air velocity in fpm Preliminary measured air flow rate in cfm Preliminary measured velocity in fpm Final air flow rate in cfm Final velocity in fpm Space temperature in deg F
Air Terminal Unit	
Identification Location Rooms or area served Type (constant volume, variable volume, fan powered, etc.) Manufacturer Manufacturer model number and serial number Fan motor horsepower and rpm Fan motor FLA and service factor	Supply Air: Maximum airflow in cfm Minimum airflow in cfm Primary Air: Maximum airflow in cfm Minimum airflow in cfm Fan: Airflow in cfm Total static pressure in inches wg Motor voltage Motor amps Reheat Coil: Air flow rate in cfm Entering-air temperatures in deg F Leaving-air temperatures in deg F Water flow rate in gpm Entering-water temperature in deg F Leaving-water temperature in deg F

TEST AND BALANCE PROCEDURES

Test Instruments Calibration: Instruments for air and water test and balance shall have been calibrated within a period of six months prior to balancing and tested for accuracy prior to start of work. Calibrate vibrometer utilized for vibration testing before each day of testing using calibrator provided with the meter. Calibrate sound meters before each day of testing using calibrator complying with ANSI S1.40 and NIST certification.

Air Systems Test and Balance Procedures:

General: Air handling and distribution systems, including supply, return, ventilation, and exhaust airflows shall be balanced and adjusted in accordance with Chapter 10 of ASHRAE Standard 111 and Section 7.2.2 of ASHRAE Standard 62.1. Maximum air quantities at each outlet or inlet shall not vary more than -5% to +10% from those indicated on the Drawings.

Water Systems Test and Balance Procedures: Water circuits shall be adjusted for proper flow in accordance with Chapter 11 of ASHRAE Standard 111, within plus or minus 10% of design values.

A/E QUALITY CONTROL CHECK

In the presence of the A/E during or before the Final Inspection, the TAB subcontractor shall verify the balance of the air and water systems as follows:

Each terminal unit will be checked for proper airflow and water flow.

At least 15% of registers, grilles, and diffusers will be checked for proper air flow via calibrated flow hood..

The TAB subcontractor shall provide all test instruments required for the Owner/Engineer check of the air and water systems balance.

During the A/E check, the TAB contractor shall verify the full range of air and water flows for the items selected to be checked. The Contractor shall have the controls sub-contractor present during the A/E check of the air and water systems balance.

END OF SECTION 230593

SECTION 230596 – HVAC SYSTEMS VERIFICATION

PART 1 – GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

GENERAL

HVAC systems verification shall be performed by the Contractor and shall include the following:

Establish a verification "team" consisting of the installing personnel, the controls subcontractor, and the testing, adjusting, and balancing (TAB) subcontractor(s).

Systematically evaluate all installed HVAC components, equipment, subsystems, and systems to ensure that they are working in accordance with this design documents. This includes measuring temperatures and flow rates from all HVAC devices and calibrating all sensors to a known standard.

Perform verification procedures, equipment functional performance tests, and tests of the sequences of operations to verify that the controls are providing the correct interaction between equipment, subsystems, and systems.

PART 2 – DESIGN INTENT

GENERAL

The contract documents define the requirements for HVAC components, equipment, subsystems, and systems, along with the control requirements for each element. It is the intent of the Designer that all HVAC components, equipment, subsystems, and systems shall perform in accordance with the stipulated requirements through the entire operational range of each element, while satisfying temperature, humidity, air quality, acoustic, and vibration criteria defined in Section 230510.

SEQUENCES OF OPERATION

Sequences of operation shall be as indicated on Drawings.

PART 3 – FUNCTIONAL PERFORMANCE

SYSTEMS START-UP

Appendix 230596 outlines basic start up and check out requirements for HVAC systems and equipment. Generally these procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct. These items provide a minimum or guideline for development of start up procedures, checklists and tests along with the general requirements indicated above (that are common to all). **Contractor shall synthesize these requirements with that of the manufacturer's and/or applicable codes and standards to develop specific and itemized start up procedures specific to that installed on this project.**

FUNCTIONAL PERFORMANCE TESTS AND CERTIFICATION

Functional performance tests shall be performed in accordance with the checklists in Appendix 230596 to prove all modes of the sequences of operation and to verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. **The checklist shall then be repeated until it has been completed with no errors.**

Functional performance tests shall begin only after all work and testing required in related specification sections have been successfully completed, after all pre-verification checks have been successfully completed, after the control systems are fully functional, after the testing, adjusting, and balancing work has been completed and after all test and inspection reports and operation and maintenance manuals required have been submitted and reviewed by the A/E.

Based on the functional performance test checklists in Appendix 230596, the verification team shall prepare standardized reporting forms for each item of equipment, subsystem, and system to document the required functional performance tests. Each test shall be certified with the following statement and the signature and date of signing by each member of the verification team:

“We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

“Signature and Date:

Mechanical Contractor’s Representative _____
Testing, Adjusting and Balancing Representative _____
Controls Sub-Contactor Representative _____"

END OF SECTION 230596

APPENDIX 230596 – HVAC SYSTEMS VERIFICATION CHECKLISTS

Section	Component
232113	Hydronic Piping Systems

START-UP CHECKS

Confirm that piping has been cleaned, flushed, and tested in accordance with Section 230555 and ASME B31. Provide pressure test report.

Confirm that thermometers, gages, and pete's plugs are installed in accordance with Section 230521

Confirm that piping is adequately supported and vibration isolation is addressed in accordance with Section 230529 and 230548.

Confirm that piping has been painted and that piping and valves have been labeled in accordance with Section 230553.

Confirm that piping insulation and jackets are in accordance with Section 230719, as applicable.

Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).

Remove and clean strainer screens.

Vent system to remove all trapped air.

START-UP PROCEDURES and FUNCTIONAL PERFORMANCE TESTS

Conduct a full dynamic test of the equipment safeguards. Draft switches should be tested and tripped to assure proper action results.

Section	Component
233600	Air Terminal Units

START-UP CHECKS

Check that ductwork entering terminal unit is straight for at least 4 duct diameters, or provided with flow straightening device. Confirm that flex duct is correctly supported.

Check power and control voltages

Check calibration and operation of the controlling elements.

Check control valves for required close-off and fail/normal position

Ensure terminal unit is properly supported and that integrity of vibration isolation has been maintained where applicable.

Start fans and ensure proper rotation. Measure and record motor amperage and voltage.

Install new filters where required.

START-UP PROCEDURES

Calibrate and adjust the airflow control parameters. Set applicable min and max setpoints.

Check the heating device and control to ensure functionality and proper installation.

Check stroke and range on the valve and ensure it closes and seals tightly. Ensure the coils are undamaged, combed, and vented.

FUNCTIONAL PERFORMANCE TESTS

Fan Powered VAV Terminal Units:

Verify VAV box response to sensor call for heating via set point adjustment. Changes to be cooling setpoint to heating set point and return to cooling set point.

Verify cooling damper closes to minimum position and, upon further drop in space temperature, heating coil activation and deactivation.

Check primary air damper maximum/minimum airflow settings and compare to design and TAB data. Check blower fan flow and compare to design and TAB data.

Verify free operation of fan backdraft damper (ensure no primary air is being discharged through the recirculated air intake).

Verify that no recirculated air is being induced when box is in full cooling.

END APPENDIX 230596

SECTION 230713 - HVAC DUCT INSULATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Flame/Smoke Ratings: Provide composite duct insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 225) method.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

PART 2 - PRODUCTS

INSULATION MATERIALS

Mineral Fiber Insulation: Insulation made up of fibers manufactured of glass, rock, or slag, processed from the molten state, with or without a binder.

Mineral Fiber Board Insulation: ASTM C 612, Type IA or IB, with factory-applied jacket. Insulation density shall be 3.0 pcf or greater and conductivity, k, tested in accordance with ASTM C 518 or C 177 at 75ºF mean temperature shall not exceed 0.25 Btu-in./(hr-sf-ºF).

Mineral Fiber Blanket Insulation: ASTM C 553, Type II, with factory-applied jacket. Insulation density shall be 1.00 pcf and conductivity, k, tested in accordance with ASTM C 518 or C 177 at 75ºF mean temperature shall not exceed 0.27 Btu-in./(hr-sf-ºF).

Factory-Applied Jacket for Mineral Fiber Insulation: Jacket and tape shall comply with ASTM C 1136, Type II, as follows:

FSP Jacket: Jacket consisting of aluminum foil, fiberglass-reinforced scrim with polyethylene backing.

FSK Jacket: Jacket consisting of aluminum foil, fiberglass-reinforced scrim with kraft-paper backing.

Jacket Tape: Seams and tears/damage to jacket shall be sealed with foil-face, vapor-retarder type tape matching the factory-applied jacket, with acrylic adhesive, 3" wide, and not less than 6.5 mils thick.

Adhesives shall be water-based, low VOC type complying with ASTM C 916.

JACKETING MATERIAL

Insulated ductwork exposed to viewshall have field-applied jacket Woven glass-fiber fabric "canvas" of approximately 8 oz./sq. yd. Cover fabric with one coat of fire retardant coating prior to finish painting.

PART 3 - EXECUTION

INSULATION APPLICATION

Indoor ductwork shall be insulated as follows:

Ductwork exposed to view shall be insulated with 2” thick mineral fiber board insulation.

Concealed ductwork shall be insulated with 2” thick mineral fiber blanket insulation. Insulate duct at hangers with 6” wide, 2” thick mineral fiber board insulation.

GENERAL INSTALLATION REQUIREMENTS

No straps on rectangular ductwork, trapeze only. Install mineral fiber board insulation between trapeze and rectangular ductwork, inside jacket.

Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

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.

Install insulation with longitudinal seams at top and bottom of horizontal runs.

Install multiple layers of insulation with longitudinal and end seams staggered.

Keep insulation materials dry during application and finishing.

Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

Install insulation with least number of joints practical.

Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

Install insulation continuously through hangers and around anchor attachments. 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 mastic.

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.

Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

Install insulation with factory-applied jackets as follows:

Draw jacket tight and smooth.

Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket.

Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c. Tape laps with 3" wide foil tape.

For below ambient services, apply vapor-barrier mastic over staples.

Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal. Apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

INSTALLATION OF MINERAL FIBER INSULATION

Blanket Mineral Fiber Insulation Installation: Secure with adhesive and insulation pins, as follows:

Apply adhesives according to manufacturer's recommended coverage rates per unit area of duct and plenum surfaces.

Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts. **Adhesive secured pins are prohibited.** Pins shall be installed as follows:

On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

Do not overcompress insulation during installation.

Impale insulation over pins and attach speed washers.

Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface.

Cover exposed pins and washers with 3" long piece of 3" wide foil continuous vapor barrier tape.

For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface.

Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

Board Mineral Fiber Insulation Installation: Secure with adhesive and insulation pins in accordance with the requirements for blanket insulation above, with the following modifications:

For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

EXISTING INSULATION REPAIR

Repair damaged sections of existing duct or plenum insulation damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 225) method.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

PART 2 - PRODUCTS

PIPING INSULATION MATERIALS

Mineral Fiber Insulation:

Insulation shall be made of fibers manufactured from glass, rock, or slag, processed from the molten state, with or without a binder.

Insulation shall be heavy density pre-formed sectional type for piping in accordance with ASTM C 547, Class I, factory-jacketed.

Glass fiber insulation shall be rated for fluid temperature up to 850-degrees F.

Mineral wool insulation shall be rated for fluid temperature to 1200-degrees F.

Closed Cell, Flexible Elastomeric Insulation: Flexible elastomeric, closed cell, thermal insulation in accordance with ASTM C534, Type I, preformed tubes, black in color, rated for piping temperatures from to 220 degrees F. Insulation shall be AR/Armaflex or equivalent.

Jackets for Piping Insulation: Insulation jackets shall be all-service vapor retarder type as follows:

Piping Operating at Temperatures Above Ambient: Jacket shall be "ASJ" type, consisting of white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

Covering for Piping Insulation Exposed to View:

Encase all indoor straight piping insulation with woven glass-fiber fabric "canvas" of approximately 8 oz./sq. yd. Cover fabric with one coat of fire retardant coating prior to finish painting.

Encase all indoor pipe fittings insulation with one-piece pre-molded 20-mil UV-inhibited PVC fitting covers complying with ASTM C450 for dimensions and fastened as per manufacturer's recommendations.

PART 3 - EXECUTION

PIPING SYSTEM INSULATION APPLICATIONS

Piping systems shall be classified in accordance with MSS SP-58, as follows, and be insulated as hereinafter specified:

Classification	Temperature Range (deg F)
Type 1: Hot Systems	Type 1A: 120-200

Classification Type 1A Piping: Insulate HVAC hot water supply and return piping with mineral fiber insulation to the following minimum thickness:

Up through 1-1/4" IPS	1-1/2"
1-1/2" IPS and larger	2"

Exceptions:

Omit insulation on hot piping within unit cabinets; and on unions, flexible connections, and expansion joints.

GENERAL INSTALLATION REQUIREMENTS

For Classification Type 1 piping, do not insulate valves, strainers, unions, etc. unless indicated hereinafter.

Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

Insulate pipe elbows using preformed fitting insulation or mitered sections made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of

pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

Install removable insulation covers for valves and piping specialties and where indicated on the Drawings. Installation shall conform to the following:

Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

Install insulation 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. Install insulation with longitudinal seams at top and bottom of horizontal runs.

Install multiple layers of insulation with longitudinal and end seams staggered. Do not weld pins, clips, or other insulation attachment devices to piping, fittings, and specialties.

Keep insulation materials dry during application and finishing.

Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

Install insulation with least number of joints practical.

Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

Install insulation continuously through hangers and around anchor attachments:

At pipe hangers and supports, protect the insulation from compression as follows:

Piping Classification Type 1A shall be insulated with cellular glass piping insulation for the length of the insulation shield specified in Section 230529. Insulation vapor barrier shall be lapped and sealed in accordance with manufacturer’s instructions to maintain continuous vapor barrier integrity.

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.

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.

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 mastic.

Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

Install insulation with factory-applied jackets as follows:

Draw jacket tight and smooth.

Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket.

Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

Flexible elastomeric insulation shall be installed in strict accordance with the manufacturer's written installation instructions.

Insulation Installation on Straight Pipes and Tubes:

Install un-slit insulation sections to the maximum extent possible. Seal butt joints with manufacturer's recommended adhesive.

Where slit insulation sections must be used, seal longitudinal seams and butt joints with manufacturer's recommended adhesive. **Secure slit sections on both sides of each fitting and 12" o.c. on straight pipe or tubing runs with 2" wide, 1/8" thick insulation tape matching the adjacent insulation. The use of metal bands, plastic bands, and wire are prohibited.**

Insulation Installation on Pipe Flanges:

Install pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

Insulation Installation on Pipe Fittings and Elbows:

Fabricate mitered sections of pipe insulation as fitting covers.

On soldered, brazed, or buttwelded joint fittings, insulation that fits the adjacent piping may be used.

For screwed or socket weld joint fittings, the insulation inside diameter shall match the outside diameter of the adjacent piping. Fitting covers shall lap adjacent piping insulation by at least 1".

Secure insulation materials and seal longitudinal seams and butt joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

Insulation Installation on Valves and Pipe Specialties:

Install preformed valve covers manufactured of same material as pipe insulation when available.

When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

Secure insulation to valves and specialties and seal longitudinal seams and butt joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

INSTALLATION OF MINERAL FIBER INSULATION

Insulation Installation on Straight Pipes and Tubes:

Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.

For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

Insulation Installation on Pipe Flanges:

Install preformed pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

Insulation Installation on Pipe Fittings and Elbows:

Install preformed sections of same material as straight segments of pipe insulation when available.

When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

Insulation Installation on Valves and Pipe Specialties:

Install preformed sections of same material as straight segments of pipe insulation when available.

When preformed sections are not available, install mitered sections of pipe insulation to valve body.

Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. Install insulation to flanges as specified for flange insulation application.

FIELD-APPLIED JACKET INSTALLATION

Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.

Completely encapsulate insulation with coating, leaving no exposed insulation.

EXISTING INSULATION REPAIR

Repair damaged sections of existing mechanical insulation damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

END OF SECTION 230719

SECTION 230913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for all components including the following to demonstrate compliance with the contract documents:

Catalog cut sheets of all equipment used. This includes, but is not limited to sensors, actuators, valves, and dampers.

Catalog cut sheets of air measuring stations used for the volumetric control system. Include as a separate volumetric control section velocity transmitters, static pressure transmitters, and flow chart for sequence of operation.

As applicable, control air supply components and sizing computations for compressors, receivers, and main air piping.

Operation and Maintenance (O/M) Manuals: See Section 019913 for requirements. O/M manuals shall include the following, at a minimum, elements:

General description and specifications for all sensors and final control elements.

Complete troubleshooting procedures and guidelines for all sensors and final control elements.

Documentation of all required maintenance and repair/replacement procedures.

PART 2 -PRODUCTS

ELECTRONIC SENSORS

General: Provide all remote sensors and instrumentation as required for the control system. All sensors shall have accuracies as stated hereinafter. Electronic sensors shall include integral transmitter and provide input analog input signal as either 4-20 mA or 0-10 VDC over the full range specified below.

Sensor Accuracy and Range: Each electronic sensor shall have accuracy and range as follows:

Sensed/Measured Variable	Sensor Characteristics Required	
	Measurement Accuracy	Range
Space Temperature	±1°F	+50°F- +85°F
Ducted Air Temperature	±1°F	+40°F- +140°F
Airflow (terminal)	±10% of full scale	
Air Pressure (ducts)	±0.1 in. w.g.	0 - 5.0 in. w.g.
Air Pressure (space)	±0.01 in. w.g.	-0.25 - 0.25 in. w.g.

Temperature Sensors: Sensors shall be RTD or Thermistor type as follows:

Space Sensors: Space sensors shall have blank covers and no temperature display. No setpoint adjustment by occupants, ***unless specifically indicated on the Drawings***, shall be provided. Where setpoint adjustment is indicated on the Drawings, range of adjustment shall be limited to +/- 2 deg F from setpoint defined by control sequences.

Duct-mounted Sensors: Sensors shall be averaging sensors with a sensing element incorporated in a copper capillary with a minimum length of 20 feet.

Occupancy/Vacancy Sensor: Sensor shall be dual technology ultrasonic (US) and passive infrared (PIR) type with relay photocell and manual adjustments (8-30 minutes) for time-on delay and sensitivity. Relay photocell must be capable of operation by N/O + N/C relay contact SPDT; 500 mA rated @ 24VDC with adjustable natural light override ranges from 0 to 100 footcandles. Sensor shall provide up to 2000 square feet coverage and have 360-degree field of view with vertical sensing adjustment. Sensor shall be designed for ceiling mounting and provided with two color LED lamps, red for infrared motion, green for ultrasonic motion. Sensor must operate indoors at temperatures from 32F-104F and relative humidity (non-condensing) 0%-95%. Sensors shall also be provided with a single pole, isolated relay for interface with BAS. Relays and contact ratings shall be clearly indicated in submittal literature. Provide 5 year warranty. Sensor shall be user-adjustable for the following alternative modes of operation for each independent relay:

Occupancy Mode: Sensor shall automatically energize controlled elements when the space becomes occupied and de-energize them when the space becomes unoccupied. (Mechanical Equipment)

Vacancy Mode: Controlled elements shall be energized by manual occupant control when the space is occupied and de-energized by the sensor when the space becomes unoccupied. (Lighting)

FINAL CONTROL ELEMENTS AND OPERATORS:

Control Valves:

Valve bodies shall be designed for not be less than 125 psig working pressure or 150% of the operating pressure, whichever is greater. Class 125 bronze body valves and Class 150 stainless steel valves shall comply with ASTM B16.5. Cast iron components shall meet the requirements of ASTM A126, Class B.

Select and size control valves as hereinafter specified and submit complete valve selection list with shop drawings.

Hydronic Control Valves:

General:

Control valve body, packing, and trim shall be designed to withstand the system static head plus the greater of 150% of the maximum pump head or the pump cut-off head at the maximum temperature and velocity of the controlled medium and have no stem lift and leak-by at close-off.

All valves 1-1/2" NPS and smaller shall be brass or bronze bodied with Type 316 stainless steel internal trim (including seats, seat rings, and valve stems). Non-metallic parts of valves shall be designed for 250-degree F operating temperature. Valves shall be packless construction or equipped with pressure sealed molded packing and backseating ring. Dual temperature valves shall be specifically designed for the service.

Pressure *dependent* valves 2" NPS and larger shall be extended neck, full lug butterfly type, as specified in Section 230523. Bracket and actuator linkage shall be furnished and shall be factory-mounted. Valves and linkage shall be selected for 60 degree angular opening for modulating duty and 90 degree opening for 2-position duty.

Pressure *independent* valves 2" NPS and larger shall have flanged cast iron or steel bodies with Type 316 stainless steel internal trim (including seats, seat rings, and valve stems). Non-metallic parts of valves shall be designed for 250-degree F operating temperature. Valves shall be packless construction or equipped with pressure sealed molded packing and backseating ring. Dual temperature valves shall be specifically designed for the service.

Two-Way Pressure Dependent Modulating Control Valves:

Valves shall be modulating globe or ball type and have *equal percentage* position vs. flow characteristic.

Valve rangeability shall be at least 100:1

Two-Way Pressure Independent Modulating Control Valves:

Valves shall consist of flow regulating balancing valve, modulating temperature control valve, and differential pressure control device within a single valve assembly that shall have *equal percentage* position vs. flow characteristic.

Valves shall maintain flow rate dictated by the input control signal over the full flow range of 0-100% to maintain flow within ±5 % accuracy, automatically compensating for system pressure changes from 5 psig up to at least 50 psig.

Control Valve Sizing:

Modulating 2-Way Control: Select control valve C_v to provide control valve authority of at least 0.3 when authority is defined as the pressure drop through the valve at full flow divided by flow through the valve at minimum (0 gpm) flow. Minimum valve pressure drop at full flow shall be the greater of 10 feet of water [4 psig] or the pressure drop through the heat exchanger.

Damper and Valve Operator/Actuators: Unless indicated otherwise on the Drawings, all actuators shall have fail-safe operation via a mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.

Actuators for Pressure Independent Control Valves: Actuators shall be electronic type furnished and mounted by the control valve manufacturer. Actuators shall accept 2-10 VDC or 4-20 mA input signal from the facility direct digital control system. Actuators shall be electronically programmed by use of external computer software provided by the valve manufacturer for adjustment of flow settings.

Types of Operators/Actuators: Valve operators for control valves shall be electronic**.**

Electronic Damper and Valve Operator/Actuator: Shall be direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

Electric Two-Position Damper Operator/Actuator: Provide a bi-directional, 120-VAC operator with spring return, size actuator for running torque at 7 inch-lb/sq. ft. of damper.

Position Indicator: Actuators shall be provided with a compact, adjustable visual position indicator attached to the actuator. As a damper or valve is cycled, the position indicator shall rotate, causing a cylinder to rotate inside a second cylinder with "display windows." When the damper or valve is open, the word "OPEN" shall be displayed in the two windows located 180° apart. When the damper or valve is closed, the word "CLOSED" shall be displayed. Between the two extremes, the display shall be scaled in degrees (0-90).

PART 3 - EXECUTION

INSTALLATION

Sensors and Controls:

Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.

Label or code each field wire at each end. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.

Temperature Sensors:

Install all sensors and instrumentation according to manufacturer’s written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.

Mount sensors rigidly and adequately for the environment within which the sensor operates.All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.

Duct Pressure/Airflow Sensors/Switches:

Sensors shall be connected to pressure or airflow monitoring stations.

Actuators:

Mount damper and valve actuators according to manufacturer’s written instructions.

Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.

Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.

FIELD TEST AND INSPECTIONS

Upon completion of installation of each sensor or final control element, field inspect and mechanically and electrically test for proper function.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230913

SECTION 230923 – EXTENSION OF EXISTING DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

Section 230913, which specifies the requirements for sensors, devices, actuators, and final control elements utilized by the DDC system.

QUALITY ASSURANCE

Single Source Responsibility of Supplier: The controls system sub-contractor shall be responsible for the complete installation and proper operation of the control system. The sub-contractor shall be in the regular and customary business of design, installation and service of computer-based building environmental control systems similar in size and complexity to the system specified. The sub-contractor shall be the manufacturer of the primary DDC system components or shall have been the authorized representative for the primary DDC components manufacturer for at least 5 years. The sub-contractor must be licensed as an “unlimited electrical contractor” in the state in which the Project is constructed, shall have a factory-certified trainer on staff, and provide 5 day per week local technical support. **Submit documentation of these sub-contractor qualifications to the A-E for review.**

Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.

Verification of HVAC systems requires participation by the direct digital controls subcontractor as a member of the "Verification Team". See Section 230596 for requirements.

GUARANTEE PERIOD SERVICES

Maintenance of Control Hardware: The Contractor shall inspect, repair, replace, adjust, and calibrate, as required, the file server/workstation(s), associated peripheral equipment, and control units. The Contractor shall then furnish a report describing the status of the equipment, problem areas (if any) noticed during service work, and description of the corrective actions taken. The report shall clearly certify that all software is functioning correctly.

Maintenance of Control Software: The Contractor shall maintain all software. In addition, all factory or sub-vendor upgrades to software shall be added to the systems, when they become available, at no additional cost to the Owner.

Service Period: Routine system service shall be provided on a monthly basis for the first six (6) months of the guarantee period and at least every three months during the second six (6) months. Calls for service by the Owner shall be honored within 24 hours and are not to be considered as part of routine maintenance.

Service Documentation: A copy of the service report associated with each routine service visit or Owner-initiated service call shall be provided to the Owner and the A-E with 10 days after the date of each service call.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, model number, and other relevant technical data. Include technical data for operator workstation equipment, interface equipment, control units, communicating thermostats, transducers/ transmitters, sensors, actuators, valves, relays/switches, control panels, operator interface equipment, etc.

DDC System Software:

Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

List of graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

Controlled Systems:

Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Bill of materials of equipment indicating quantity, manufacturer, and model number for each controlled system

Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring and termination labels.

Details of control panel faces, including controls, instruments, and labeling.

Written sequences of operation. The sequence shall include reference to schematic diagram(s) that is/are applicable. Include "on/off" and "occupied/unoccupied" schedules, as applicable for each controlled system.

Schedule of software interlocks between HVAC equipment or components. Include any "groupings" of controlled systems that may be used to initiate on/off control of any other controlled system.

Schedule of dampers including size, leakage, and flow characteristics.

Schedule of valves including flow characteristics.

DDC System Hardware:

Wiring diagrams for control units and communicating thermostats, with termination numbers.

Schematic diagrams and floor plans for field sensors and control hardware.

Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.

Graphic Displays: Include color prints or "screen shots" of each proposed graphic display proposed, complete with clear indication of (1) static components and dynamic components and (2) "on"/"off"/"alarm" condition designation convention.

Samples for Initial Selection: For each color available for each type of thermostat, sensor, etc. cover exposed to view with factory-applied color finishes.

Data Communications Protocol Certificates:

For extension of an existing DDC system that utilizes the BACnet communications protocol, certify that each proposed DDC system component complies with ASHRAE Standard 135-2012 **and is BACnet Laboratory tested and certified**.

For extension of an existing DDC system that utilizes LonWorks technology using CEA-709.1-C as the communications protocol, each proposed DDC system component shall be certified by LonMark International.

Closeout Submittals:

Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.

Interconnection wiring diagrams with identified and numbered system components and devices.

Keyboard illustrations and step-by-step procedures indexed for each operator function.
Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

Calibration records and list of set points.

Software and Firmware Operational Documentation: Include the following:

Software operating and upgrade manuals.

Program Software Backup: On a magnetic media or compact disc, complete with data files.

Device address list.

Printout of software application and graphic screens.

Software license required by and installed for DDC workstations and control systems.

PART 2 - PRODUCTS

SYSTEM DESCRIPTION

Provide extension to the Owner's existing direct digital control system (Johnson Controls, Inc.) utilizing the Owner's network system consisting of existing server, LAN/WAN, and server-resident network software.

Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on a token-passing network and programmed to control mechanical systems.

JOB CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)

LAN hardware shall be designed to operate in ambient conditions of 65 to 90 degrees F at a relative humidity of 20 to 80 percent, non-condensing.

Digital control equipment shall comply with the following:

Digital control equipment shall be designed to operate in ambient conditions of 35 to 120 degrees F at a relative humidity of 0 to 95 percent non-condensing.

Control units as hereinafter specified shall operate properly with power fluctuations of plus 15 percent to minus 10 percent of nominal supply voltage.

Electric and electronic equipment shall be properly mounted and organized in a grounded and Listed NEMA 1 cabinet (panel). Cabinets or enclosures shall protect equipment from dust, liquids or accidental blows.

NETWORK COMPONENTS

Via either direct or web browser access, the following functions shall be provided:

Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.

Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any control unit.

Network Software: Software shall be upgraded as necessary to include the following capabilities:

I/O capability from any network operator workstation or through a browser. The system operator interface shall be an easy to use, self-guiding, menu-penetration, windowing approach. Key features that shall be included in the interface are as follows:

Object/point descriptions used for applications such as graphics, reports, alarms, etc. shall be same as the object/point name as specified above.

Engineering units shall be the English ("inch-pound") system.

Interactive operation and help messages.

Organization of points into logical groups or “systems” and an information penetration scheme that provides quick and simple method for maintenance staff to determine HVAC conditions and problems at any school, as follows:

Initial facility information display will be one or more graphic "floor plans" that include basic site information and specific room by room data. Each of these data points are displayed as "hot buttons" so that selecting any data display takes the user to next, more detailed information level. The floor plan display(s) shall provide display of room numbers, along with temperature, humidity, CO_2, occupancy, etc. conditions in each space. Designation of the HVAC terminal unit, air unit, and/or system serving each space shall also displayed and selecting that hot button shall take the operator to the detailed system points display for that terminal unit, air unit, and/or system serving the room.

At the HVAC system, subsystem, or component level, a graphical display or "tree structure" structure display may utilized, as selected by the user.

Site information shall include direct hot button links to primary heating and cooling systems. (For example, selecting "CHWSTemp" shall take the operator immediately to the graphic or tree structure display of the facility chilled water cooling system, while selecting "HWSTemp" shall lead to the facility hot water heating system.)

Pictorial representation of data on color graphic terminals with dynamic data.

Capability to alternate between graphic and text displays for the same logical group.

Automatic system diagnostics; monitor system and report failures of both controlled equipment and control system components.

Database creation and support.

Automatic and manual database save and restore.

Dynamic color graphic displays with multiple screen displays at once.

Custom graphics generation and graphics library of HVAC equipment and symbols.

Alarm and event processing.

Provide audible, visual, and printed means of alarm indication. The alarm dialog box shall al ways become the top dialog box upon receipt of an alarm irrespective of the foreground application. Alarms assigned for printout shall be routed to the destination printer. In addition, alarms shall be capable of being routed to specified personnel by means of pager or mobile telephone.

User-defined alarm messages shall be generated and delivered in conjunction with the alarm notification.

Alarms shall be routed to the appropriate destination device(s), based on time and other conditions. An alarm shall be able to initiate sequences, print, be logged in the event log, generate custom messages, and automatically display an associated system graphic.

Any object in the system shall be configurable to generate alarms on transition in and out of normal state. The operator shall be able to configure the alarm category, alarm limits, alarm limit differentials, states, al arm message, states and reporting actions for each alarm in the system.

Minimum alarm categories required are notification, maintenance, critical and security.

Automatic restart of field equipment on restoration of power.

Data collection, reports, and logs. Include standard reports for the following:

Current values of all objects.

Current alarm summary.

Disabled objects.

Alarm lockout objects.

Logs:

Retrieve and display default logs, including "all points log", "system points log", "alarm log", etc.

Create, retrieve, and display trend logs, in real time, of historical object data stored in remote CUs.

Maintain trend log files saved to hard disk for subsequent use in spreadsheet or database programs.

Dynamically graph the trend logged object data by creating two-axis (x, y) graphs that simultaneously display values relative to time for up to eight objects in different colors.

It shall be possible to trend log any number of points at least equal to twice the number of connected physical points. Any object in the system (physical or calculated) may be logged.

Once established, trend logs shall continue until deleted by user. Data storage sufficient for at least 30 days shall be provided for each trend log.

Custom report development.

Utility and weather reports.

Application editors for controllers and schedules.

DIRECT DIGITAL CONTROL UNITS

General: Multiple digital control units (CUs) shall be provided. ***CUs shall be fully field programmable and the use of firmware-based application specific controllers is prohibited.*** All control functions shall be resident in the CUs, including those involved in building-wide strategies.

Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

Control units shall fully comply with the system architecture and communication requirements specified hereinbefore.

Units shall monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

Stand-alone mode control functions shall operate regardless of network status. Functions include the following:

Global communications.

Discrete/digital, analog, and pulse I/O.

Monitoring, controlling, or addressing data points.

Software applications, scheduling, and alarm processing.

Testing and developing control algorithms without disrupting field hardware and controlled environment.

Provide local operator interface to provide for download from or upload to operator workstation or diagnostic terminal unit.

Standard Application Programs:

Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, anti-short cycling, P/PI/PID control as hereinafter, DDC with fine tuning, and trend logging.

HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.

Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.

Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.

Remote communications.

Maintenance management.

Units of Measure: Inch-pound.

Local operator interface to provide for download from or upload to operator workstation or diagnostic terminal unit.

Control Modes: Control loops shall be able to utilize any of the following control modes:

Two position (e.g., on-off, slow-fast)

Proportional (P), proportional plus integral (PI), or roportional plus integral plus derivative (PID), applied as follows:

Controlled Variable	Control Mode
Space Temperature	P
Mixed Air Temperature	PI
Coil Discharge Temperature	PI (cooling), P (heating)
Hot Water Supply Temperature	P
Airflow	PI (with wide proportional band and fast reset rate) or PID
Fan Static Pressure	PI
Humidity	P (PI throttling range is less than 5%)
Dewpoint Temperature	P (PI throttling range is less than 2 F)

For any unlisted application, the control mode shall be as approved by the A-E.

I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

Digital (Binary) Inputs: Allow monitoring of on-off signals without external power.

Pulse Accumulation Inputs: Accept up to 10 pulses per second.

Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

Digital (Binary) Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.

Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.

Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

Universal I/Os: Provide software selectable binary or analog outputs.

Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

Output ripple of 5.0 mV maximum peak to peak.

Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.

Built-in over-voltage and over-current protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

Minimum dielectric strength of 1000 V.

Maximum response time of 10 nanoseconds.

Minimum transverse-mode noise attenuation of 65 dB.

Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

Diagnostic Devices: Each CU shall be supplied with connections to which Owner's maintenance personnel can connect portable diagnostic operator's terminals (PDOTs) for data display, setpoint modification, and reloading and modification of controller programs.

Control Functions: All control functions shall execute within the standalone control units via DDC algorithms. The operator shall be able to customize control strategies and sequences of operations defining the appropriate control loop algorithms and choosing the optimum loop parameters. Each CU shall include the following standalone functions:

Direct Digital Control algorithms and control sequences are to be CU resident and be capable of standalone operation. All DDC programs shall be custom written as required to meet the performance criteria spelled out in the sequence of operation paragraphs for each controlled mechanical system. PID control mode shall be employed as appropriate to the application and per sequences or operation.

Enable/Disable: All CU resident DDC programs shall be capable of being enabled or disabled from any workstation. In the enable mode all DDC loops shall be active and output signals shall be routed to the final control elements. In the disable mode all DDC loop calculations shall continue but outputs to actuators shall be suppressed. (When disabled, control outputs shall stay in the same state or position as commanded from the central or until they are manually set to automatic.)

Integral Windup Prevention: To eliminate integral windup, all PID programs shall automatically invoke integral windup prevention routines whenever the controlled unit is off, under manual control or under control of an system or time initiated program, or when the controlled unit is in the process or starting or stopping.

Default Value Operation: All CUs shall be capable of being programmed to utilize stored default values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by the central or another CU, by loss of bus communication. Individual application software packages shall be structured to assume a fail-safe condition upon loss of input sensors. Loss of an input sensor shall result in output of a sensor-failed message at the central control and command station. Each CU shall have capability for local readouts of all functions.

APPLICATION SOFTWARE

Provide the following programs in addition to control algorithms defined on the drawings:

Scheduling: Provide a calendar format for annual time-of-day scheduling for equipment operation, trending, logging and reports, etc. Provide the following minimum features:

Day-type schedules (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday, Holiday, Pre-Holiday day, Vacation day, Special Day, etc., 24 hours per day)

Monthly schedules (allow individual assignment of day types to each day of the month).

Yearly schedules (allow schedules to be applied on an annual basis and be edited and re-applied to a following year).

Provide user-defined "on-off" schedules as specified assignable to an individual HVAC system, subsystem, and/or component. This schedule shall dictate the starting and stopping times, on a daily basis, of the designated systems and components.

Provide user-defined "occupied-unoccupied" schedules as specified above for operation of each fan coil unit, blower coil unit, air-handling unit, ventilation air system, etc. This schedule shall dictate the opening and closing of ventilation air dampers, the starting and stopping of exhaust fans associated with each unit, the operation of make-up air units, etc., on a daily basis, so that ventilation air is provided only during the specific periods during which the area served is occupied.

Temporary override of above schedules shall be allowed by operators with access levels as specified above. A temporary override shall (1) extend hours of use of HVAC systems, subsystems, and/or components up to midnight on weekdays and (2) allow use of HVAC systems, subsystems, and/or components during scheduled "off" periods for a maximum of 12 hours. When an override use period terminates, the temporary override time(s) shall be voided and affected HVAC elements shall return to their normal schedules.

Optimum On/Off: Program shall consider both outdoor weather conditions and indoor thermal zone conditions to perform the following functions to minimize the operation of space cooling and heating systems:

Start HVAC equipment at the latest possible time after its scheduled “on” time in order to achieve the desired zone comfort condition in the coolest or warmest zone by its “occupied” time.

Stop HVAC equipment at the earliest possible time after its “unoccupied” time and before its scheduled “off” time and still maintain desired zone comfort condition in the coolest or warmest zone.

Coordinate automatically with on/off schedules assigned by the user.

Event Initiated Programs (EIPs): Event initiators may be any digital data point in the system, real time values, or any analog alarm limit. The EIPs shall be structured so that one initiator may set and reset the EIP as it goes from normal to off-normal and back to normal, or one initiator may set the program and a second initiator reset the program, or reset may be manual via the console keyboard. Setting an EIP shall cause a series of start or stop commands to assigned loads to be executed to EIP's points. EIP’s shall have priority assignments to allow them to override other programs in the set mode when desired. The operator's terminal shall have read-write capability for initiator load and priority assignment.

Alarm Initiation and Response:

All AI points shall have user-defined upper and/or lower condition limits. If user-defined limits are not defined, ***default limits shall be initially set as follows***:

Space temperature	5ºF below low setpoint of comfort zone or 5ºF above high setpoint of comfort zone
Space humidity	≥5% RH above setpoint
AHU mixed air low limit	≤38ºF
Cooling coil leaving air	≥60ºF
Heating coil leaving air	≤90ºF
CHW supply	≥48ºF
HW supply	≤120ºF
Low pressure steam supply	5 psig below setpoint
High pressure steam supply	15 psig below setpoint

Monitor and display "status" (on/off, high/low, open/closed, etc.) of each DI point. Motor on/off status shall be indicated by current sensing relays with field-adjustable trigger point to provide DI "switch", as hereinafter specified.

Monitor and display condition of each AO point (valve or damper percent open, motor speed percent of full speed, etc.)

An alarm shall be initiated whenever any of the following conditions occur:

Any AI point high or low limit alarm setpoint is exceeded.

Any DI status condition does not correspond to the DDC command condition (i.e., damper is closed when occupied/unoccupied schedule requires damper to be open, motor is operated in "hand" rather than "auto" mode, etc.)

Any AI or DI device fails or goes "out of range".

Any AO device fails to respond to DDC command condition.

If any AO control loop continues to cycle its output more than 40% of its range (user adjustable) 3 or more times in any 60 minute internal.

For variable air volume AHUs, if any supply fan or return/relief fan speed AO output signal remains above 95% for more than 8 hours (user adjustable) accumulated per "on" period for 3 or more consecutive "on" periods.

If any AHU coil control valve(s) AO output signal remains above 95% for more than accumulated 8 hours (user adjustable) per "on" period for 3 or more consecutive "on" periods.

If any humidifier valve AO output signal remains above 85% for more than accumulated 8 hours (user adjustable) per "on" period for 3 or more consecutive "on" periods.

During "on" periods, if any cooling coil chilled water return temperature is greater than design for more than 4 hours during which coil chilled water supply temperature was at or below design setpoint temperature.

Automatic Restart Programming:

When a power failure is detected in any phase, the DDC system shall command all electrical equipment served by the failed power source "off".

If the associated CU is powered by normal or emergency power, it may monitor its own power source as an indication of power status.

If the CU is powered by uninterruptible power supply (UPS), or if it is not capable of monitoring its own power for use in sequences, Contractor shall provide at least one voltage transformer (three phase when applicable) for each facility for the DDC system to monitor for power status.

When the DDC system detects normal or emergency power has been restored to the failed power source, all equipment served by that source that was commanded "off" shall be automatically restarted. Restart shall be sequenced by the CU network restart program with a 5 second interval between starts to minimize inrush current.

Air Flow and Pressure Control:

Air flow and static pressure shall be controlled via direct digital CUs with inputs from air flow control measuring stations and static pressure inputs as specified in Section 230913 and indicated on the Drawings. Controller outputs shall be true analog output signals. Pulse width modulation outputs are not acceptable. The airflow control programs shall be standard factory tested programs that are documented in the literature of the control manufacturer.

Duct Static Pressure Control: Systems shall consist of one or more static pressure sensors as specified in Section 230913 and indicated on the Drawings, along with relays or auxiliary devices as required to produce a complete functional system. The span of the transmitter shall not exceed two times the design static pressure at the point of measurement. The output of the transmitter shall be true representation of the input pressure with plus or minus 0.1-inch wg of the true input pressure.

For systems with multiple major “trunk” supply ducts, provide a static pressure transmitter for each trunk duct. The transmitter signal representing the lowest static pressure shall be selected as the input signal to the CU.

The CU shall receive the static pressure transmitter signal and shall provide a control output signal to the supply fan capacity control device using control modes hereinbefore specified.

Constant Volume Control: Systems shall consist of a static/total pressure sensor as specified in Section 230913 and a differential pressure transmitter, along with such relays and auxiliary devices as required to produce a complete functional system. The transmitter shall receive its primary total pressure and static pressure signal from the flow measuring station and shall have a span not exceeding three times this differential pressure at the design flow rate. The CU shall receive the transmitter signal and shall provide an output to the fan volume control device to maintain a constant flow rate. Overall system accuracy shall be plus or minus 0.008-inch velocity pressure as measured by the flow station.

Additional application control requirements shall be met as required by the DDC control logic diagrams on the Drawings.

CABLING AND WIRING

DDC Cabling: Cabling between buildings shall be fiber optic. **Network cabling within buildings shall be shielded twisted pair or fiber optic**. Cabling or wiring between control units and I/O point devices shall be as follows:

Application	Cable/Wire Type and Min. Gauge (AWG)
Digital Input Wiring	24 gauge, twisted pair
Analog Input Wiring	24 gauge, shielded twisted pair
Digital Output Wiring	24 gauge stranded for 24V 18 gauge stranded for 120V
Analog Output Wiring	24 gauge, twisted pair

Data Cable:

Twisted shielded cables shall have FFEP insulation in thermoplastic jacket, with #24 AWG stranded conductors, minimum. Shield shall be tinned, soft-copper strands formed into a braid or equivalent foil. Shielding coverage on conductors shall not be less than 100 percent.

Multimode fiber optic cables shall be 62.5/125 micron Class Ia Graded Index Multimode Optical Fiber**,** OFNR, OFNP, Outdoor or Indoor / Outdoor (I/O) NEC Rating, FDDI Compliant.

Coating Diameter: 250 Microns

Core Eccentricity: 7.5% maximum (1.5% typical)

Numerical aperture: .275 plus or minus .015

Attenuation: 3.5 dB/km @ 850 NM / 1.50 dB/km @ 1300 NM

Bandwidth: 160 MHz at 850 NM / 500 MHz @ 1300 NM

Fiber connectors: ST .75 dB maximum insertion loss

Cable bend radius: 10 times diameter

Single mode fiber optic cables shall be 8.3/125 micron Class IVa Dispersion-Unshifted Single-mode Optical Fiber, OFNR, OFNP, Outdoor or Indoor / Outdoor (I/O) NEC Rating, FDDI Compliant.

Coating Diameter: 250 Microns

Core Eccentricity: 7.5% maximum
(1.5% typical)

Attenuation: 0.5 dB/km @ 1310 NM/1550 NM

Zero dispersion wavelength 1300 -1320 NM

Cable bend radius: 10 times diameter

Control and Interlock Wiring: All 24V-120V control and interlock wiring shall comply with Section 230511 and the following:

Conductors:

All wire and conducting components shall be THWN standed copper.

Conductors shall be continuous from device to device and no splices shall be made except within device or junction boxes. ***Wire nuts and crimp slices are prohibited.***

Control wiring shall be color-coded in accordance with reviewed submittals.

Where conductors pass through a junction box or connect to a device, the conductor and the box shall be tagged to indicate the circuit and/or terminal number shown on the submittal drawings.

Raceway: Provide electrical metallic tubing (EMT), minimum 3/4" size. Fittings shall be steel insulated throat compression type. ***Set screw fittings, fittings constructed of alloys of aluminum or fittings of the indenter type are prohibited.*** Flexible metallic raceway may be utilized for the last 24" up to the connection point for devices, sensors, etc.

Routing of Raceway: Exposed raceway shall line up work true to adjacent surfaces and be placed in a workmanlike manner. Raceway shall be run at right angles to building lines; this requirement does not apply to raceway located below concrete placed as a part of this project. Raceway shall be sturdily supported and separated in a manner satisfactory to the A/E; raceway shall not be supported by the ceiling grid or ceiling grid support wires. In general, all raceway is to be concealed and routed overhead, below the floor, or in walls except in electrical or mechanical equipment rooms. Raceway in such rooms may be surface mounted.

Device Boxes: Device boxes for use in sheetrock or paneled surfaces shall be of galvanized steel, 4 inches square of a depth necessary to contain the intended device(s) and associated conductors. Boxes shall be sized to have no less than the minimum volume as required by the NEC. Boxes must be flush mounted and accommodate device(s) and all wires and connections without crowding. Boxes shall be furnished with a suitable plaster ring of the depth required to match the wall (or ceiling) material. Where the surface material or covering is combustible the front edge of the plaster ring shall be absolutely flush with the surface. Where the wall material is non-combustible, the front of the plaster must be recessed into the wall no further than 3/16 inch. Device boxes for flush mounted use in masonry walls shall be of the concrete tight masonry type sized for the number of device(s) and conductors. In locations where surface mounting of device boxes is permitted on masonry walls, provide 1/2 inch raised cover and suitable plaster ring.

Junction Boxes: Junction boxes shall be of galvanized steel of size, type, and shape for intended use and having adequate volume as required by NEC. All junction boxes shall be concealed unless specifically permitted elsewhere in these Specifications or on the Drawings. Boxes must be supported from the building structure without dependence on support of conduit, fixture support wires, ceiling support wires, or similar items.

Device and/or Junction Box Wall Penetrations: All wall penetrations at device or equipment locations must be protected in such a manner that the fire rating of the wall is maintained. ***It is the responsibility of the Contractor to assure that fire and smoke integrity of all walls is maintained at all penetration points***.

PART 3 - EXECUTION

INSTALLATION

Provide skilled technicians, properly trained and qualified for the work and directed by experienced engineers.

Except for short apparatus connections, run raceway and pneumatic tubing parallel to or at right angles to the building structure. Conceal raceway and tubing in finished spaces.

Do not run tubing or raceway concealed under insulation or inside ducts. Mount control devices, tubing and raceway located on ducts or apparatus with external insulation on standoff supports to avoid interference with insulation.

Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing. Rack connections bridging a cabinet door along the hinge side and protect from damage. Provide grommets, sleeves or vinyl tape to protect plastic tubing or wires from sharp edges of panels, raceway, and other items.

Cabling and Wiring Installation:

Raceway: All control cabling and interlock wiring shall be installed in raceway.

Exception: Where Class 2 wiring is located in concealed and accessible locations, including supply or return air plenums, plenum-rated cables complying with NFPA 262 may be installed without raceway, provided that:

Circuits meet NFPA 70 Class 2 (current-limited) requirements.

All cables shall be UL-listed for the application.

Do not install Class 2 wiring in raceway containing Class 1 wlring. Boxes and panels containing high voltage (120 V+) may not be used for low voltage wiring except for the purpose of interfacing the two via relays, transformers, etc.

Shielded, twisted pair cable shielding shall be grounded at each connection point.

Fiber Optic Cable:

Route all interior cables in raceway within walls and inaccessible ceiling spaces.

Use nylon bushings at top of conduit where stubbed in accessible ceiling spaces.

Support all cables using J type hooks where open cable is permitted.

Route all fiber optic cable in raceway with innerducts. The innerducts shall contain a pull string, if no fiber is pulled at the time of the installation of the duct.

All conduit where fiber optic cable is installed shall be sized to maintain the manufacturer's recommended bend radius of fiber optic cables. As a minimum, conduit shall be provided with long radius elbows.

All cables shall be terminated using appropriate termination equipment.

Fiber Termination Panels: Provide a rack mountable, modular cabinet capable of terminating up to 24 type ST multimode fiber cables. Panels shall be as manufactured by Ortronics, Amp, Siecor, or Superior.

Fiber Optic Testing

Upon completion of the passive optical cable system, the system must be tested to ensure compliance with the design and link loss specifications. The tests include:

Power Meter Tests: For building risers, power meter tests are required.

End-to-End Attenuation Testing: Tests shall be completed on each fiber span at both operational wavelengths:

850/1310 nm multimode

1550 nm single mode

Testing in one direction is required. Link attenuation does not include any active devices or passive devices other than cable, connectors and splices (e.g., link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers. Test results should be retained for inclusion into the documentation package.

Connector loss readings of each completed connector should be recorded using an OTDR at 850 and 1310 nm in one direction.
Optical time domain reflectometer (OTDR) signature traces of each terminated fiber should be recorded at 850 nm and 1310 nm for fiber continuity purposes. OTDR testing is mandatory for runs longer than 2 km.

Final report shall be compiled which records system configuration, fiber labels, cable routes and “as built” details. Loss measurements with calibrated light source and power meter shall be included. OTDR traces shall also be included when requested in advance.

Smoke detectors and/or fan shutdown relays initiated by a fire alarm system shall be integrated into the control system and sequence of operation as indicated and/or required.

FIELD QUALITY CONTROL

Perform the following field tests and inspections and prepare test reports after completion of DDC system installation:

After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

Test and adjust controls and safeties.

Test pneumatic components, as applicable:

After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

Pressure test control air piping at 1.5 times the operating pressure for 24 hours, with maximum 5-psig loss.

Test calibration of control units by disconnecting input sensors and stimulating operation with compatible signal generator.

Test each control point through its full operating range to verify that safety and operating control set points are as required.

Test each control loop to verify stable mode of operation and compliance with sequence of operation.

Test each system for compliance with sequence of operation.

Test software and hardware interlocks.

DDC Verification:

Verify that instruments are installed before calibration, testing, and loop or leak checks.

Check instruments for proper location and accessibility.

Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

Check instrument tubing for proper fittings, slope, material, and support.

Check installation of air supply for each instrument.

Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.

Check temperature instruments and material and length of sensing elements.

Check control valves. Verify that they are in correct direction.

Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.

Check DDC system as follows:

Verify that DDC controller power supply is from emergency power supply, if applicable.

Verify that wires at control panels are tagged with their service designation and approved tagging system.

Verify that spare I/O capacity has been provided.

Verify that DDC controllers are protected from power supply surges.

Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

CALIBRATION AND ADJUSTMENT

General:

Make three-point calibration test for both linearity and accuracy for each analog instrument.

Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

Control System Inputs and Outputs:

Check analog inputs at 0, 50, and 100 percent of span.

Check analog outputs using milliampere meter at 0, 50, and 100 percent output.

Check digital inputs using jumper wire.

Check digital outputs using ohmmeter to test for contact making or breaking.

Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

Flow:

Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.

Manually operate flow switches to verify that they make or break contact.

Pressure:

Calibrate pressure transmitters at 0, 50, and 100 percent of span.

Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

Temperature:

Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.

Calibrate temperature switches to make or break contacts.

Stroke of valves and dampers:

Without positioners, follow the manufacturer's recommended procedure, so that valve or damper is 100 percent opened and closed.

With positioners, follow manufacturer's recommended procedure, so that valve and damper is positioned at 0%, 50%, and 100% closed.

Provide diagnostic and test instruments for calibration and adjustment of system.

Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

Adjust initial temperature and humidity set points.

VERIFY SENSOR ACCURACY

Select 100% of installed gas concentration sensors for testing:

Carbon Dioxide (CO_2): Prior to placing the DDC system in operation, sensors shall be tested and recalibrated as needed in accordance with the manufacturer's written procedures. Calibration shall use a minimum of two calibration gas samples, one a 950-1050 ppm and one at either 0 ppm or 450-550 ppm, with the concentration of the calibration gas known within +/- 2%. *Sensors that cannot be calibrated to within +/- 60 ppm of calibration gas CO_2 concentrations at each test point shall be replaced*. The replacement sensor shall then be calibrated. Provide sensor test/calibration reports for review by the A/E.

Refrigerant: Test sensor calibration factor using a diluted sample of refrigerant gas at or near sensor full scale concentration level in strict accordance with the manufacturer's calibration procedure. Re-calibrate or replace sensor if calibration factor cannot be maintained within the range of 0.95-1.05. Provide sensor test/calibration reports for review by the A/E.

Select at least 10% of the installed temperature, humidity, pressure, airflow, etc. sensors, including at least one of each sensor type, for testing. If calibration of 10% or more of this sample is found to be incorrect, select an additional 10% of the installed sensors for testing. **If calibration of 10% or more of this second sample is found to be incorrect, test/calibrate all sensors.**

Sensor calibrating instruments shall be used in checkout of the overall performance. The sensors of these instruments shall be placed at the proximity of DDC system sensors to indicate the conditions of the controlled media (air, water, etc.). A preliminary evaluation shall be made as to the suitability of having the DDC system sensors checked in-place or they may be placed in simulated environment. If the response times of the two sensors (DDC system sensor and calibration sensor) are similar, testing may be performed with the sensors in place. If the conditions of the controlled media change slowly, testing may also be performed with the sensors in place. However, if the conditions of the controlled media change rapidly and the time responses of the two sensors vary considerably, testing shall be done with the sensors placed in a known environment such as a temperature bath.

Verification procedures: Verification of sensor accuracy shall be made using the following procedures. Compare readings for each sensor from the calibration instrument and the DDC system to determine if the measurement accuracy meets the requirements of Section 230913.

Temperature: Use a multi-point verification check at various points in the operating range (including minimum, typical, and maximum), utilizing a calibrated thermometer and Dewar flask or a calibrated portable drywell (±0.5ºF) temperature probe calibrator.

Relative Humidity: Use a single point calibrator or portable environmental chamber that has been lab calibrated with a NIST traceable dew point monitor (±3% RH).

Air Flow: Utilize calibrated pitot tube or propeller anemometer traverses in at least two planes upstream of the air flow monitoring station. For VAV systems, test airflows over a range of at least five flow rates between 20% and 100% of design flow.

Pressure: Use a multi-point verification check at various points in the operating range (including minimum, typical, and maximum) with a calibrated dead weight tester or an electronic pressure calibrator for ranges above atmosphere, or an accurate digital pressure gage for ranges below atmosphere.

Differential pressure: Use a dead weight tester or electronic calibrator or a magnehelic gauge with a pressure bulb to their high-pressure side to apply a known pressure at various points in the operating range (including minimum, typical, and maximum).

Very Low Differential Pressure: Use a micromanometer or digital manometer of narrow range to spot check pressures at various points in the operating range (including minimum, typical, and maximum). The manometer must be zeroed. A hand pump/bleed valve setup can be used to apply the small pressures required to the high sides. The manometer is adjusted and the instrument readings are compared at the high and low point. The temperature of the manometer fluid should be used to adjust its readings to the standard temperature conditions of the transmitter.

VERIFY FINAL CONTROL ELEMENT FUNCTIONALITY

Test each final control element operator to ensure performance in accordance with Section 230913 and the control sequences defined on the Drawings. Test shall include full range of movement, stability through that range, and power and/or control signal failure performance. Operators found to be non-functional in any way shall be replaced.

VERIFY OPERATOR AND SYSTEM FUNCTIONALITY

Verify backup system operations and switchovers including redundant processors, backup power supplies, battery backed memories, etc.

Verify DDC system command software by issuing commands at the operator's console and observing display, printer output, or HVAC equipment responses. The following software operation shall be verified:

Software for checking input commands and issuing error messages. Enter various correct and incorrect commands.

System and point addressing check. Enter command to display I/O data. Verify all data points defined on the drawings and/or required by the specifications.

Start-stop or enable-disable of HVAC equipment or DDC system control points. Enter commands to start/stop selected HVAC equipment, and to disable and enable selected points.

Operator override/automatic mode. Enter command to change selected automatic control under DDC system to manual and vice versa.

Display format. Enter commands to display data and graphics on terminal and graphic display. Check display content for adequacy and clarity as specified.

Ability to modify, cancel and confirm operator's commands. Verify by entering commands.

Set-point adjustment and limiting. Enter commands to adjust set points of controllers and range limits of the controlled media. Verify by display. Also enter commands to adjust set-points outside their range limits. DDC system shall display error messages.

System access and access level control. Try to log on to system with both incorrect and correct ID codes. Try to enter different commands with different access level of the operators. The responses of the DDC system shall be as specified.

Start/stop equipment. Enter command to start or stop selected equipment. Also reset time to initiate automatic mode. Verify responses by observation of equipment and DDC system display.

Change parameter of points. Enter commands to change parameters of selected points such as high and low limit alarms, scale factor, etc. to test the adequacy of software.

Verify graphic display of each HVAC system and component. Confirm that the graphic is in accordance with the design data and reviewed submittals, includes all data points required, displayed data is correct and in the correct format and units, and changes in point conditions or status are accurately updated. Evaluate the refresh rate of data display.

Verify report generation (status, profile, energy, etc.) by entering commands to generate reports such as all points, trend, total display of a system, timed display, and other specified reports. Examine the report content for general format, system/point code, time interval of reporting, point status/value/unit, energy amount/rate/unit, status of control and set time (manual or automatic), and other specification required information.

Check for proper operation of system status reports, including point status reviews which would include information such as points currently in alarm, points removed from alarm checking, points off of scan, etc.

Test alarm reporting by initiating alarm conditions of different points at different alarm levels in sequence to examine alarm reports. The reports shall show alarm location and device, alarm time, cause of alarm, current status of the point, etc. as required in the specifications. When alarm conditions are removed the printer shall print updated status report. Also verify audible alarm operations in accordance with specification requirements. Then initiate alarm conditions at different levels at the same time to check alarm priority.

Trending performance shall be tested by creating trend logs for each control sequence and monitoring the trend reports throughout the period that each control sequence is tested.

TEST CONTROL SEQUENCES

General: The test procedures described below do not check the details of the software, rather, they try to verify the final output as indicated by the field equipment. Before testing each program the required input and output of the program and those listed in the contract specifications shall be compared to make sure that the program covers the specified operations. Verification of HVAC equipment operation (such as equipment status or temperature of space air) may be done by either (1) actual observation of equipment status and test instruments, or (2) obtaining DDC system reports if the accuracy of these reports has been verified previously.

Basic Functional Tests: Through the user interface conduct the following series of tests:

Raise/lower space temperature setpoints in software to verify if the system responds in accordance with design requirements.

Raise/lower discharge temperature setpoints and verify control valve and damper positions.

Initiate a high priority, off-hours alarm and verify that the remote notification procedures are carried out correctly.

Verify that the interface with system safeties allow operation of dampers, etc., if safety conditions are met.

Conduct an emergency start-up after power failure test. Verify that all systems return to automatic control.

Verify DDC system maintains required outside air requirements under low airflow conditions.

Disconnect communication cable to the DDC system and verify if the DDC panel can control the respective system (stand-alone control).

Disconnect a sample of DDC space-temperature sensors and verify control sequence default.

Test HVAC Systems Sequences of Operation:

Day-night setback control. Confirm that required input data is provided. To test control, change the setback time from occupied to unoccupied time and confirm that HVAC systems respond to the setback mode. If system is an air-handling system, the outside air damper should close and the fan should cycle to maintain the setback temperature setpoint.

Change the setback temperature setpoint to 5°F higher than the actual space temperature. The system should operate to increase the space temperature to the new setpoint condition. For air-handlers, the outside air damper should remain closed.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 230923

SECTION 233100 – HVAC DUCTWORK

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

NFPA Compliance:

Comply with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*.

Comply with NFPA 90B, *Standard for the Installation of Warm Air Heating and Air Conditioning Systems*.

SMACNA Compliance: Fabricate and install all ductwork and ductwork accessories in accordance with *HVAC Duct Construction Standards - Metal and Flexible*.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data and installation instructions for ductwork and products.

PART 2 - PRODUCTS

DUCTWORK MATERIALS

Galvanized Sheet Metal: Except as indicated otherwise, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality, with G 90 zinc coating in accordance with ASTM A 525 and mill phosphatized for exposed locations. Stamp gauge and manufacturer's identification on each sheet. Break sheets so that identification is exposed.

Flexible Ducts: Metallic or non-metallic, insulated flexible ductwork complying with UL 181B. Provide 1" thick continuous flexible fiberglass sheath with vinyl vapor barrier jacket.

DUCT FABRICATION

Shop fabricate ductwork in 4, 8, 10 or 12-ft lengths, unless otherwise indicated. Preassemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.

Shop fabricate supply, return, and ventilation air ductwork of gauges and reinforcement complying with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, **with the exception that sheet metal less than 24-ga. shall not be used for rectangular duct**, in accordance with the following:

Application	Construction Pressure Class
Return Ductwork	-2" W.G.
Supply Ductwork Downstream of Air Terminal Units	+1" W.G.
Supply Ductwork With Fan Static Pressure Less Than 2.5" W.G.	+2" W.G
Supply Ductwork with Fan Static Pressure Greater Than 2.5" W.G.	+3" W.G

Shop fabricate exhaust ductwork of the following gauge sheet metal with reinforcement complying with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible:*

Maximum Diameter or Maximum Rectangular Dimension (inches)	Sheet Metal Gauge
8	24
18	22
30	20
>30	18

Elbows/Tees:

Radius elbows and tees shall be fabricated as **full radius** elbows with the centerline radius 1.5 times the duct width.

Square throat elbows shall be constructed with double-wall airfoil turning vanes properly spaced for the duct width. Turning vanes and vane runners shall be constructed in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, Figure 4-3. **Square throat elbows may be used only when the available space is insufficient for use of a full radius elbow**.

ROUND AND OVAL DUCTWORK

Construction: Construct round and flat oval ductwork in accordance with Section 3 of SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, complying with the Pressure Class designations hereinbefore specified. Use spiral lockseam construction for ductwork up to 58” diameter and welded longitudinal seam for larger ductwork.

Exception: Round ducts that connect to air outlets or inlets may be constructed with a snaplock longitudinal seams complying with Fig. 3.2 of SMACNA's *HVAC Duct Construction Standards - Metal and Flexible.*

Double-Wall Ductwork: Round or flat oval ductwork shall be double walled where indicated. Construct with outer pressure shell, insulation layer, and perforated inner liner. Construct shell and liner of sheet metal as hereinbefore specified. Use spiral lockseam construction for ductwork up to 58” diameter and welded longitudinal seam for larger ductwork, in minimum gages listed.

Inner Liner: Perforated sheet metal with holes for 23% open area. Provide metal spacers welded in position to maintain spacing and concentricity.

Insulation: Mineral fiber insulation complying with Section 230713, 2" thick. Cover insulation with polyester film complying with UL181, Class 1.

PART 3 - EXECUTION

INSTALLATION OF DUCTWORK

Assemble and install ductwork to achieve air-tight operation with no objectionable noise, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth.

Support ducts in accordance with Section 230529 to hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor or roof penetration in accordance with Section 230529.

At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure fabricated of 6 mil PVC film or other covering that will prevent entrance of dust and debris until time connections are to be completed.

Routing:

Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs unless such routing is clearly indicated on the Drawings. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct useable space or block access for servicing building and its equipment. Coordinate layout with suspended ceiling, lighting, fire suppression systems, and similar finished work.

Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Unless indicated otherwise, install duct as high as possible.

Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation.

Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above ceilings.

Elbows: **Utilize radius elbows for all changes of direction unless specifically indicated otherwise on the drawings or space limitations dictate the use of square throat elbows with turning vanes**. Where square throat elbows with turning vanes are installed, provide a duct access door or panel immediately upstream of each elbow.
Sealing: Ductwork shall be sealed in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, as follows:

Duct Construction Class	Seal Class
+/- 1" W.G. or less	C
+/- 2" W.G.	B
+/- 3" W.G. and greater	A

Testing:

Ductwork indicated to be constructed in accordance with Pressure Class +/-3" W.G. or greater shall be tested, section by section, in accordance with SMACNA's HVAC *Air Duct Leakage Test Manual*. Air leakage factor (CL), computed in accordance with the following relationship, shall be less than or equal to 6.0:

$$CL = \text{Leakage rate (cfm/100 sf of duct surface)} \times (\text{Test static pressure})^{0.65}$$

Ductwork utilized as part of a smoke control system shall be tested, section by section, in accordance with SMACNA's HVAC *Air Duct Leakage Test Manual* and leakage shall not exceed 5% of design airflow.

INSTALLATION OF FLEXIBLE DUCTS

Flexible duct shall only be allowed where indicated on the drawings, installed as follows:

Install duct fully extended; do not install in the compressed state or use excess lengths.

Avoid bending ducts across sharp corners or incidental contact with metal fixtures, pipes or conduits. Radius at center line of bends shall not be less than one duct diameter.

All connections, joints and splices should be made in accordance with the manufacturer's installation instructions.

All tapes, mastics and non-metallic fasteners (plastic clamps) used for field installation of flexible ducts should be listed and labeled to UL 181B.

Sheet metal collars to which flexible ducts are attached should be a minimum of 2 inches in length and shall be beaded.

Sheet metal sleeves used for joining two sections of flexible duct should be a minimum of 4 inches in length and beaded on both ends.

Maximum Length: **Do not exceed 8'-0" extended length**.

Metal Duct Connection: Spin-in conical connectors with integral balancing damper shall be used for connecting flexible runouts to metal ductwork.

ADJUSTING AND CLEANING

Clean ductwork internally, section by section, as it is installed, of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration. After cleaning, seal open ends and connections with 6 mil PVC film.

Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233100

SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

NFPA Compliance: Comply with applicable provisions of NFPA 90A and/or NFPA 90B pertaining to installation of ductwork accessories.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction, and installation instructions.

PART 2 - PRODUCTS

AIRFLOW DAMPERS

Low Pressure Manual (Balancing) Dampers:

Construction: Dampers installed in dishwasher exhaust ductwork, return air ductwork in natatoriums, and in other wet locations shall be constructed of Type 316 stainless steel, including shafts and hardware exposed to the airstream. All other dampers shall be constructed of G90 galvanized steel with zinc-plated shafts and hardware exposed to the airstream. Single blade or multiblade volume damper shall be constructed in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible*, Figures 7-4 and 7-5.

Quadrant Locks: Provide each low pressure balancing damper with a quadrant lock device on one end of shaft, and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

Control Dampers: Dampers shall be constructed of 0.108-inch-minimum thick steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick steel with maximum blade width of 8 inches and maximum length of 48 inches. Dampers installed in dishwasher exhaust ductwork, return air ductwork in natatoriums, and in other wet locations shall be constructed of Type 316 stainless steel, including shafts and damper hardware exposed to the airstream. All other dampers shall be constructed of G90 galvanized steel with zinc-plated shafts and hardware exposed to the airstream.

Secure blades to 1/2-inch-diameter axles with oil-impregnated sintered bronze blade bearings, blade-linkage hardware, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of each blade.

Operating Temperature Range: From minus 40 to plus 250° F.

Edge Seals: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for Leakage Class I according to ANSI/AMCA 500-D.

FLEXIBLE DUCT CONNECTORS

Provide flexible connector between ductwork and any fan or air-handling unit connected to the ductwork. Connectors shall be fabricated of noncombustible fabrics and any coatings or adhesives applied shall comply with UL 181, Class 1. Frame shall be steel and fabric shall be 26 oz/sq. yd or heavier. Connector shall be sized for minimum 50% additional travel and/or deflection at full airflow.

Where flexible connectors are located downstream of electric heating coils, the connector shall be rated for application at temperatures up to 250°F.

PART 3 – EXECUTION

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233300

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE:

NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A.

ARI Compliance: Air terminals shall be tested, rated, and certified in accordance with ARI Standard 880.

Flame/Smoke Ratings: Provide composite insulation/liners (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 225) method.

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturers Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished, schedule showing drawing designation, number furnished, model number, size, and accessories furnished.

PART 2 - PRODUCTS

GENERAL REQUIREMENTS

General: Primary air terminal devices shall be provided as indicated on the Drawings.

The type of device, capacity rating, and control type and arrangement shall be as scheduled Drawings. Units shall be selected to obtain sound levels defined in Section 230510.

Casings: Casing shall be constructed of minimum 20 ga. aluminum or steel, reinforced to SMACNA Standards for +4" W.G. duct construction. All seams and joints shall be continuously mechanically sealed by welding, Pittsburgh locks, drives, or equivalent and sealed in accordance with SMACNA's *HVAC Duct Construction Standards - Metal and Flexible* for +4" W.G. duct construction. **Pop rivets, punch connections, and/or sheet metal screw joint connections are not acceptable.** Leakage shall not exceed 2% with air pressure to +4" W.G. inside casing.

An access door must be located between primary damper and hot water coil to allow inspection of damper and cleaning of coil.

Casing Liner: Enclosures shall be internally insulated with minimum 1" thickness of rigid fiberglass board in accordance with ASTM C 612, Type II, with kraft paper and foil jacket, in accordance with ASTM C 921,Type 1, installed on the airstream side. All leading and trailing edges shall be protected from airstream contact by metal flanges, channels, etc.

Air Flow Sensor: Air flow sensor shall be of a cross configuration located at the inlet of the assembly. The sensor shall have multiple total pressure sensing ports and a center averaging chamber designed to accurately average the flow across the inlet of the assembly. Sensor shall provide accuracy within 10% of full range. Provide external capped test ports on both total pressure and static pressure tubes to enable testing the airflow without having to remove pressure lines to the controller.

Terminal Unit Controller: Manufacturer-furnished, factory-installed unit controls, including final control elements, shall meet the requirements of Section 230924 and the control I/O points and sequences of operation shown on the Drawings. **Unit controllers shall interface seamlessly with the direct digital control (DDC) system specified in Sections 230913 and 230923, fully complying with the operational requirements for "Control Units" specified in Section 230923**.

ABOVE CEILING AIR TERMINAL UNITS

Series Air Volume Fan Powered Terminal Unit: Unit shall be completely factory-assembled and designed as a "series configured" constant volume fan unit with pressure independent VAV valve and reheat coil that are modulated by a room thermostat. The unit fan shall run continuously when indexed to operate with its associated AHU.

The single fan shall be constructed of steel and have a forward curved, dynamically balanced wheel with ECM direct drive motor. Motor shall be of energy efficient design, with integral thermal overload protection and permanently lubricated sleeve type bearings, and shall be designed for use with fan speed controller. Provide an anti-backward rotation device. Provide vibration isolation between motor and fan assembly.

The terminal shall utilize a manual SCR speed control as the means of setting fan airflow. The speed control shall incorporate a minimum voltage stop to ensure that the motor cannot operate in a stall mode.

Primary VAV damper assembly shall be heavy gauge steel with shaft rotating in bronze oilite self-lubricating bearings or equivalent. Shall be permanently marked on the end to indicate damper position. The damper shall incorporate a mechanical stop to prevent overstroking and a seal to limit close-off leakage to not more than 5 cfm at 4" w.g. inlet static pressure.

Terminal unit shall incorporate a single point electrical and control connection for the entire terminal unit. All electrical components shall be mounted in a control box and the entire terminal shall be listed as a complete assembly.

Provide 1" flat panel filter with MERV 8 rating.

Heating coil shall be as indicated on the Drawings and shall be 5/8" tubes, single tube continuous circuit, same-end connection coil. Provide access panel in unit upstream of coil.

Provide return air inlet attenuator.

PART 3 - EXECUTION

ABOVE CEILING AIR TERMINAL UNITS INSTALLATION

Locate units as indicated on the Drawings, taking care that units are located only above lay-in or otherwise accessible ceilings and where there is sufficient clearance from piping, raceway, and ductwork for the unit to be maintainable.

Install level and plumb in strict accordance with the manufacturer's requirements and support units in accordance with Section 230529.

Locate units generally in accordance with the drawings, but ensure that access to the units is not blocked by light fixtures, piping, ductwork, etc.

Provide not more than 6'-0" length of flexible supply duct the same diameter as the unit connection. Avoid tight turns, offsets, kinks, etc. in the supply duct and **arrange supply duct so there is at least 24" straight duct upstream of the unit pitot tube assembly**.

Provide flexible duct connector on unit discharge in accordance with Section 230529.

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650, *Standard for Air Outlets and Inlets*.

ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70, *Method of Testing for Rating the Air Flow Performance of Outlets and Inlets*.

NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*.

ASTM Compliance: Paint hardness shall pass 125 hour ASTM B 117 salt spray test, 500 hour ASTM D-870 water impression test, and ASTM D-2794 reverse impact cracking test with a 50 in/lb force applied.

Acoustic Criteria: HVAC equipment shall be selected and installed to comply with the acoustic criteria defined in Section 230510.

SUBMITTALS

General: Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification. Where a submitted item does not **comply fully** with each and every requirement of the Specifications, the submittal shall clearly indicate such deviations. Identification requirements for non-complying features of items are very specific. See Section 019913 for exact requirements.

Manufacturer's Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.

Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.

PART 2 - PRODUCTS

REGISTERS, GRILLES AND DIFFUSERS

General: Diffusers, registers, and grilles for supply and return air shall be provided as indicated on the Drawings. Units shall be selected for noise levels required by Section 230510, with "draftless" distribution (terminal air velocity 50 fpm or less). Units that are noisy in the opinion of the A-E, shall be removed and replaced with acceptable ones. Performance based on volume controls fully opened.

Units shall be furnished with gaskets at edges to prevent leakage.

The interior portions of wall grilles and registers, including connecting duct, which are exposed to view, shall be painted flat black.

Manufacturer's model numbers specified herein are intended for ease of identification and comparison. Equivalent products by manufacturers other than those listed, equal in appearance and performance, may be acceptable upon review by A/E.

Unless indicated otherwise on the Drawings, all registers, grilles, and diffusers shall be aluminum construction.

Standard Blade Sidewall Supply Register and/or Grille **(Type-F)**: Supply register and/or grille that is adjustable double deflection type with horizontal front blades, constructed of 0.05" thick aluminum and finished baked white enamel unless otherwise noted. Blades shall be spaced 5/8" – 3/4" apart. Frame style shall match surface type(s). Register or grille shall be as follows:

Manufacturer	Aluminum Construction Model No.
Titus	300FL
Tuttle & Bailey	A54
Price	620
Nailor	51DH

Standard Blade Sidewall Return Register Grille **(Type-V)**: Return grille that is single deflection type with fixed horizontal blades at 35-40 degrees, constructed of 0.05" thick aluminum and finished baked white enamel unless otherwise noted. Blades shall be spaced 5/8" – 3/4" apart. Provide filter frame with hinged-tab mechanism, where scheduled. Frame style shall match surface type(s). Register and/or grille shall be as follows:

Manufacturer	Aluminum Construction Model No.
Titus	350FL
Tuttle & Bailey	A70D
Price	630
Nailor	5145H

PART 3 - EXECUTION

INSTALLATION

Install diffusers, registers, and grilles in full accordance with the manufacturer's recommendations. **Modifications in ductwork, accessories, and arrangement from that indicated on the Drawings, but required for integration of the diffusers, registers and grilles proposed into the system as designed shall be the responsibility of the Contractor.**

Unless indicated otherwise on the Drawings, registers, grilles, and diffusers shall be provided with balancing dampers located at the branch duct connection, not at the air distribution device. Where a balancing damper is indicated at the register, grille, or diffuser, it shall be a rectangular opposed blade damper for installation in square or rectangular necks or a radial opposed blade damper for installation in round necks. **The use of butterfly dampers or horizontal radial dampers at air distribution devices is prohibited.**

OWNER INSTRUCTION AND TRAINING

Provide Owner instruction and training in accordance with Section 019926.

END OF SECTION 233713

SECTION 260000 - SUMMARY OF ELECTRICAL WORK

Engineer of Record for electrical work is Matthew J. Johnson, PE, Stanford White, Inc., 1620 Midtown Place (27609), P. O. Box 19944, Raleigh, NC 27619. Electrical work shall be defined by drawings numbered with the prefix "E", the general provisions of the Contract including General Conditions and Supplementary Conditions, Division 1 Specifications sections, and Division 26-28 Technical Specifications listed below. In addition, electrical work may be defined by reference to other documents from any of the above named sources as well as by project addenda.

DIVISION 26 - ELECTRICAL

Section	Title
260000	Summary of Electrical Work
260500	Basic Electrical Requirements
260519	Secondary Voltage Wires and Cables
260526	Grounding
260529	Supporting Devices
260533	Electrical Identification
260534	Raceways
260535	Electrical Boxes and Fittings
260593	Electrical Connections for Equipment
260800	Testing and Placing in Service
260923	Lighting Control Devices
265000	Lighting Fixtures

DIVISION 27 - COMMUNICATIONS

Section	Title
270528	Telephone Raceway System

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

Section	Title
283110	Fire Alarm System Modifications

END OF SECTION 260000

SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SCOPE

The electrical design for this project is based on the requirements of the *National Electrical Code* (NEC), NFPA-70, 2017 Edition. Where not restricted to more stringent requirements by the Drawings and Specifications, the minimum requirements of the NEC shall prevail.

Contractor shall coordinate the work and equipment of this Division with the work and equipment specified elsewhere in order to assure a complete and satisfactory installation.

It is the intention of these Specifications and Drawings to call for finished work, tested and ready for operation. Whenever the words "supply," "provide," or "furnish" are used, it shall mean "furnish and install complete and ready for use at no additional cost."

Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the Work the same as if herein specified or shown.

Some items of equipment are specified in the singular; however, the Contractor shall provide and install the number of items of equipment as indicated on the Drawings, and as required for complete systems. The words “and” and “or” shall be interpreted in both the singular and plural sense (and/or) as appropriate to the use.

Electrical service entrance equipment arrangements for temporary and permanent connections to the Owner's system shall conform to the Owner's requirements. Coordinate circuit breakers with the existing system.

All ampacities or other conductor references where indicated or otherwise specified in the Drawings or Specifications are based on copper conductors. **Aluminum conductors are not acceptable and will not be permitted.**

DEFINITIONS

Definitions for "Concealed" and "Exposed" are provided for the purpose of specifying wiring methods or for defining the appearance of finished work and are not the same as definitions used in the National Electrical Code.

Concealed: Work within or behind various construction elements or in crawl spaces or trenches that is not exposed to view when the project is complete.

Exposed: Not "concealed" as defined above, or anything exposed to view when the project is complete.

Labeled: Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization acceptable to the Authority Having Jurisdiction (AHJ) and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed: Equipment or materials included in a list published by an organization acceptable to the Authority Having Jurisdiction (AHJ) and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets appropriate designated standards or has been tested and found suitable for use in a specified manner.

Wiring: Cable, raceways, fittings, mechanical supports, wire, junction boxes, device boxes, outlet boxes, switches, cutouts, and related items.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

ENERGIZED SYSTEM WARNING

Extreme caution is enjoined with regard to work with and around energized electrical equipment. The Contractor is urged to coordinate all such activities with the Owner or the local electric utility so that electrical equipment may be de-energized as required to safely perform necessary construction activities as defined in the Drawings and Specifications. Suitable OSHA approved lockout-tagout procedures shall be used when circuits or equipment have been de-energized for the purpose of performing construction activities. All work practices related to worker safety are the complete responsibility of the Contractor.

DUTIES OF CONTRACTOR

The Drawings are generally diagrammatic in nature and are neither intended to show each fitting, box, elbow, offset, hanger, *etc.*, nor a complete detail of all work to be done. The Drawings are for the purpose of illustrating the type of system, showing raceway sizes, *etc.*, and special conditions considered necessary for the experienced mechanic to take off materials and lay out work. This Contractor shall be responsible for taking such measurement as may be necessary at the job and adapting his work to local conditions.

Contractor shall furnish and install all materials called for or reasonably implied in these Specifications and accompanying Drawings. Apparatus must be furnished complete and ready for operation in every respect. Materials and equipment called for in the Specifications and not indicated on the Drawings, or indicated on the Drawings and not called for in the Specifications, shall be furnished by the Contractor.

Contractor is responsible for familiarizing himself with the project area and details of the construction of building. Work performed under these Specifications that is installed improperly or which requires modification due to improper reading or interpretation of building plans shall be corrected or otherwise modified as directed by the A-E without additional cost to the Owner.

Contractor shall follow Drawings in laying out work and shall refer to drawings of other trades to verify exact spaces in which work will be installed. Arrange installed items in such a manner as to maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, A-E shall be notified before proceeding with installation.

INSPECTIONS

The contractor shall notify the office of the local Authority Having Jurisdiction, to schedule required inspections. This shall include all inspections of concealed work, interior and exterior, as well as intermediate and final reviews.

COOPERATION WITH OTHER TRADES

The Contractor shall give full cooperation to other trades and shall furnish any and all information necessary to permit the work of other trades. Information to be provided by the Contractor includes, but is not limited to templates, patterns, setting plans, and shop details as may be necessary for the proper installation of work and for the purpose of coordinating adjacent work. Information required by other trades shall be provided in a timely manner and shall be sufficient to allow the work of such other trades to proceed with the least possible interference or delay.

Where the work of the Contractor will be installed in close proximity to, or may interfere with work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. **If the Contractor installs his work before coordination with other trades, he shall make the necessary changes in his work to correct the condition without extra charge.**

Scaled Shop Drawings: If so directed by the A-E, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 3/8"=1'-0", clearly showing how his work is to be installed in relation to the work of other trades.

SAFETY REQUIREMENTS

All systems shall be installed so as to operate in a safe manner; all moving parts shall be covered where there is any possibility of danger from such moving parts. All rough edges of equipment and materials shall be made smooth.

All safety controls shall be checked under the supervision of the Owner's representative and two (2) copies of test data showing setting and performance of safety controls shall be submitted to the A-E by the Contractor.

During the construction the Contractor shall keep the site reasonably clean of debris and upon completion of construction he shall clean up the premises to remove all evidence of his work. The Contractor shall provide, at no additional cost to the Owner, additional cleaning of the site as directed by the Owner. In addition, upon completion of construction, he shall clean, wash and/or polish all fixtures, equipment and exposed material and leave each item clean, bright, and without blemish. Damaged items shall be replaced or repaired in a manner satisfactory to the Owner by the Contractor at no additional cost to the Owner.

It shall be the responsibility of the Contractor to maintain a safe working environment at all times and to comply with all OSHA regulations for the duration of the project.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Manufacturer's Data: Submit manufacturer's technical product data.

NAMEPLATE DATA

Each item of electrical utilization equipment shall be provided with a permanent operational data nameplate that shall, as a minimum, indicate the following: equipment manufacturer, product name, model number, serial number, capacity, voltage requirements, and either full load current or full load volt-amperes. Labels of tested compliances and similar essential data shall be a part of this label or located nearby. All equipment nameplates shall be in an accessible location.

In the event that the installation of equipment renders the manufacturer's nameplate inaccessible, the above information shall be etched onto a laminated plastic nameplate securely fastened to the equipment by no less than two machine screws or by other fastening methods approved by the A-E.

FLASH PROTECTION WARNING

Each piece of new electrical equipment, such as switchboards, parallel switchgear, panelboards, circuit breaker enclosures, control panels, motor control centers, transfer switches, etc. that are likely to require examination, adjustment, servicing or maintenance while energized, shall be field marked in a clearly visible location on the equipment enclosure to warn qualified persons of potential electric arc flash hazards, in accordance with NEC 110.16.

ACCESSIBILITY

Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with all other trades whose work is in the same place and shall advise the General Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required for such installations.

Contractor shall locate all equipment that must be serviced, operated, or maintained in fully accessible positions and shall coordinate with other trades as necessary to meet the workspace requirements of the National Electrical Code. Equipment where such space is required includes switchboards, motor control centers, panelboards, fire alarm control panels, telephone and data terminal panels and cabinets, and similar items.

Minor deviations from Drawings may be made to allow improved accessibility. Submit requests for all changes to the A-E for approval. Relocation of equipment, should such be required to meet NEC workspace requirements, shall be made by the Contractor at no additional cost.

CONCEALED RACEWAY

In general, all raceway or cable wiring methods in finished spaces shall be run concealed in walls, partitions, structural concrete panels, or above ceilings.

Exterior Raceway: Raceway may not be routed on exterior surfaces of the building or across a building roof (either above, below, or within roof insulation) unless specifically indicated on the Drawings.

Raceway Below Concrete Floor Slabs: Raceway may not be routed below concrete floor slabs unless such is specifically shown on the Drawings.

Concealment of raceway and covering of same shall not be done until authorized by the Authority Having Jurisdiction (AHJ). This applies to all interior work and exterior work.

SLEEVES AND PLATES

Contractor shall provide and locate all sleeves and inserts required, or shall be responsible for the cost of cutting and patching required where sleeves and/or inserts were not installed, or where incorrectly located. The Contractor shall be responsible for all drilling required for the installation of his hangers.

Sleeves shall be provided for all raceway passing through concrete, masonry, or tile wall, floor, or overhead deck construction. Sleeves shall be constructed of Schedule 40 black steel pipe unless otherwise indicated on Drawings. Sleeves through concrete beams shall be constructed as indicated on Drawings.

Fasten sleeves securely in walls so that they will not become displaced when other construction is built around them. Take precautions to prevent concrete, plaster, or other materials being forced into the space between raceway and sleeve during construction.

Escutcheon plates shall be provided for all exposed (where permitted) raceway passing through walls and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the raceway. Where plates are provided for pipes passing through sleeves that extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

SUPPORTS, ATTACHMENTS

Contractor shall furnish and install all necessary supports required for all electrical equipment, lighting fixtures, raceway, outlet boxes, panelboards, generators, and for all other equipment furnished under this contract, and shall submit drawings to the A-E for approval before purchase, fabrication, or construction of same.

All equipment, unless otherwise shown, shall be securely attached to the building structure in an approved manner.

Attachments shall be of a strong and durable nature; any attachments that are deemed by the A-E to be insufficient due to reasons of strength, location, quality, or appearance shall be replaced as directed at no additional cost to the Owner.

Framing members shall be standard rolled steel shapes, ASTM A36 steel, except that members welded to main structural member shall be of the same specification as the main structural member.

Framing shall be "simple beam" type with end connections welded or bolted for shear loads. Cantilevers may be used when detailed or specifically approved. Location of supplementary framing shall be subject to approval. Welding, where required, shall be performed by certified welders.

Framing members shall be designed for their actual loads with allowable stresses set forth in the AISC Specifications and the AISC Code, without excessive deflection and with consideration for rigidity under vibration, in accordance with standard structural practices. Supplementary framing, including design loads, member size and location shall be clearly shown on shop drawings.

When supplementary framing is indicated, verify that dimensions are suitable and that framing is structurally adequate for the equipment furnished.

FIRE RATED CONSTRUCTION

The fire rating of all floors, ceilings, and partitions shall be maintained. It is the responsibility of this Contractor provide and install any necessary fire resistive components so that the fire integrity of all fire rated structures supporting or containing items required under Divisions 26-28 will not be diminished by the installation of such items. Where device or junction boxes penetrate any fire rated structure, the boxes shall be located in such a manner as not to reduce the fire rating of the structure. Where the Drawings indicate adjacent boxes or devices in rated partitions that would reduce the fire rating of the partition if unprotected, suitable Listed protection methods shall be used to insure the fire rating of the partition will not be decreased by the proximity of other boxes or penetrations.

Where recessed fixtures are used in fire rated ceilings, suitable construction shall be installed above and around the fixture so that the fire rating of the ceiling is maintained. Refer to Architectural Drawings for fire ratings of ceilings.

Where recessed panelboards, recessed cabinets, or other items are located in a fire rated partition, suitable construction behind and around the item shall be used to maintain the fire rating of the partition.

Where fire resistive insulation or other coverings have been applied to a structure or to structural elements to obtain a fire rating and this insulation or covering is removed or otherwise disturbed by the installation of Division 26-28 components or other related items, this Contractor shall be responsible for restoring the material to a condition that matches the original fire protective ability.

Approval must be obtained from the A-E before any boxes, devices, or other components are relocated for the purpose of maintaining fire ratings.

TESTING LABORATORY APPROVAL

All equipment shall be approved for the intended use and shall be Labeled or Listed. In any case where the suitability for a particular application is in question by the A-E or inspection authorities the Contractor shall furnish appropriate standards covering the specific piece of equipment in question. Such standards, if required, shall be requested by the A-E in writing and shall be furnished by the Contractor at no additional cost.

PERSONNEL GROUND FAULT PROTECTION

Personnel ground fault protection is to be provided for certain receptacles as indicated on the Drawings and/or as required by the National Electrical Code. Protection is to be provided by the use of GFCI receptacles; the use of GFCI circuit breakers is not acceptable for the protection of general use receptacles. GFCI receptacles may not be used to protect other downstream non-GFCI receptacles unless specifically indicated on the Drawings.

If required, use GFCI circuit breakers to protect equipment or dedicated receptacles in locations as indicated on Drawings or panel schedules. GFCI receptacles may not be used to protect downstream circuit components.

TYPICAL MOUNTING HEIGHTS OF DEVICES

Typical mounting heights for electrical equipment shall be as follows unless otherwise noted on Drawings:

DEVICE	MOUTING HEIGHT ABOVE FINISHED FLOOR (AFF)	TO
Toggle Switches	3'-6"	Center Line
Receptacles	1'-6"	Center Line
Telephone Outlets	1'-6"	Center Line
Data Outlets	1'-6"	Center Line

SCAFFOLDING, RIGGING, HOISTING

The Contractor shall furnish all scaffolding, rigging, hoisting and related sub-contract services necessary for equipment delivery and final placement as indicated on the Drawings.

All scaffolding, rigging and hoisting equipment shall be removed from the job site in a timely manner when such equipment is no longer required.

ELECTRICAL CIRCUITS

Circuit designations and connections are shown on the Drawings. Indicated circuit numbers and circuit breaker positions are mandatory unless changes are specifically approved by the A-E in writing.

Electrical neutral connections are indicated on the Drawings. Neutrals may not be reconfigured or otherwise changed without specific approval in writing from the A-E.

Request for circuit or neutral changes **can not be a part of the equipment submittal process.**

EQUIPMENT CONNECTIONS

In general, provide complete electrical power supply system connections to all equipment shown on Drawings. In addition, provide disconnection and re-connection to the power system of any items that are indicated on the Drawings as being moved or relocated.

Control wiring shall be installed in raceways and box system separate from power wiring, unless otherwise indicated on Drawings. Wiring within equipment enclosures shall be in raceways provided under this section of the Specifications unless approved raceway is provided by the manufacturer of the equipment or unless the equipment is listed for use as a raceway.

ELECTRICAL PROVISIONS FOR DIVISION 23

Division 26-28 Contractor shall provide complete power wiring to a disconnecting means provided under Division supplying the equipment. Extension of power from the disconnecting means to the utilization equipment shall be made under the Division supplying the equipment.

Starters, contactors, and similar control equipment shall be furnished and installed by other divisions unless specifically shown on the electrical Drawings. Control wiring is furnished by the Division supplying the control equipment.

Fuses for fused disconnects are furnished and installed by the division supplying the equipment to be protected.

Refer to Section 230511, *ELECTRICAL PROVISIONS FOR HVAC WORK* for a complete description and breakdown of the responsibility of each trade (Division 23 and Divisions 26-28).

END OF SECTION 260500

SECTION 260519 - SECONDARY VOLTAGE WIRES AND CABLES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical products, of types and ratings required in this Section, whose products are Listed and Labeled for the purpose intended. Subject to compliance with requirements provide devices equivalent to one of the following:

Rome
Senator Wire & Cable Company
General Cable Company
Southwire Company

Codes and Standards:

NEC Compliance: Comply with NEC requirements as applicable to construction, installation and color coding of electrical wires and cables.

Testing Laboratory Compliance: Provide wiring/cabling and connector products that are Listed and Labeled.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on electrical wires, cables and connectors.

PART 2 - PRODUCTS

SECONDARY VOLTAGE WIRES, CABLES, AND CONNECTORS

General: Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information. Connections shall be designed and constructed using connectors as recommended by manufacturer for a complete installation for the application indicated. Aluminum conductors for the service entrance conductors only. All other conductors shall be specified as copper conductors with conductivity of not less than 98% at 68° F.

Building Wires: Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Contractor to comply with project's installation requirements, NEC and NEMA standards. Select from the following Listed types those wires with construction features that fulfill project requirements:

Type THWN/THHN: For general use as interior branch circuits, feeders and service entrance conductors in non-underground dry and wet locations; maximum operating temperature 90° C (194° F). Insulation, flame-retardant, moisture- and heat-resistant, thermoplastic; outer covering, nylon jacket; conductor, annealed copper.

Type XHHW: For general use in underground raceway and wet locations or as specifically indicated on the Drawings; maximum operating temperature 90° C (194° F). Insulation, moisture and heat-resistant cross-linked polymer; conductor, annealed copper. Aluminum conductors for the service entrance only. All other conductors shall be specified as copper.

Building wire shall be installed in raceway for all applications. Cables are not approved for use in this project under Division 26.

Building wire shall be installed in raceway for all applications, except as specifically noted below for cables.

Connectors:

General: Provide factory-fabricated, metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following, those types, classes, kinds and styles of connectors to fulfill project requirements:

Type: Pressure, threaded

Class: Insulated

Kind: Copper (for Cu to Cu connection)

Style: Wirenut, wingnut, power distribution block

Use power distribution blocks or other splicing device having a minimum of one clamping screw per conductor where conductor size or quantity exceed limits for "wirenut" or "wingnut" type connectors.

Provide power distribution blocks that are attached to the gutter, box, or enclosure into which they are installed. Free-floating, unattached power distribution blocks are not acceptable.

Provide suitable insulating covers for all connection devices where such insulation is not a part of the device design.

Use of split bolt connectors, insulation piercing connectors, or tape as a means of insulating connection devices is not acceptable.

PART 3 - EXECUTION

INSTALLATION OF WIRES AND CABLES

General: Install wires and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

Coordinate wire/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires/cables with other work.

Circuits of size #8 AWG and larger shall have Class B stranded conductors.

Power and lighting circuits #10 AWG and smaller shall have solid conductors. The minimum size for all power and lighting circuits shall be #12 AWG.

Control wiring shall have stranded conductors and a minimum size of #14 AWG.

Maximum size for feeders and service conductors shall be 500 kcmil.

Increase Drawing indicated size of conductors for ampacity and temperature rating as described below:

Conductor sizes shown on Drawings are based on the use of terminations Listed and Labeled for use at 75° C. (167° F.). Where terminations are not Listed and Labeled for use at 75° C. (167° F.), the Contractor shall increase the size of the conductor as required to meet the temperature rating of the conductor in accordance with NEC Article 110.14(c). Conductor size increases required under this section shall be made without additional cost.

Increase Drawing indicated size of conductors for voltage drop as follows:

Use #10 AWG conductor for 20 Ampere, 120 Volt branch circuit home runs longer than 50 feet, unless otherwise noted on Drawings.

Use #10 AWG conductor for 20 Ampere, 277 Volt branch circuit home runs longer than 100 feet, unless otherwise noted on Drawings.

Conduit runs shall contain the number of phase conductors shown on the plans. A dedicated neutral shall be installed for each phase conductor served by single pole, 120 and 277 Volt, 20 Amp circuit breakers. Multi-pole circuit breakers serving 120 and 277 Volt, 20 Amp multi-wire branch circuits with a common neutral shall not be permitted. Conduits runs shall contain related grounding and/or isolated grounding conductors.

Conduit runs that contain more than one neutral shall have each neutral conductor uniquely identified at each termination, splice and where routed through junction or pull boxes. Neutral conductors containing a factory applied, trace line along the length that matches the color of the associated phase conductor shall be used to meet this requirement. Machine printed labels with the panel and associated circuit number shall also be permitted for identifying neutral conductors. Colored tape and pre-printed tags shall not be acceptable.

Feeders and/or branch circuits shall not be combined either with each other or one with another into junction boxes, pull boxes, device boxes, manholes, or other common routing unless such routing is specifically indicated on the Drawings.

Neatly train wiring inside boxes, equipment and panelboards; Avoid bundling conductors with lacing or cable ties so that generated heat may be more easily dissipated.

Conduit runs indicated on the Drawings as composed of parallel runs of conductors shall be made identical with respect to length, conduit size, wire type, insulation type, routing, and terminations at each end.

Conductors Shall Be Color Coded as Follows:

Grounding Conductors: Green

Isolated Grounding Conductors: Green with yellow tracer

Grounded Neutral Conductors: White for 120 V systems, gray for 277 V systems

Ungrounded Phase Conductors for 208Y/120V Systems: Black (phase A), red (phase B), and blue (phase C)

Ungrounded Phase Conductors for 480Y/277V Systems: Brown (phase A), orange, (phase B) and yellow (phase C)

Switch Leg Travelers: Violet

Provide other wire colors as indicated on the Drawings.

Remarking of insulation colors by use of colored marker tape shall be permitted only as allowed by the NEC.

Install exposed cables (where permitted) parallel and perpendicular to surfaces, or exposed structural members. Cables shall follow surface contours, where possible.

Completely and thoroughly swab raceway system before installing conductors.

Branch circuit wiring shall not loop through receptacle terminals, but shall be connected by means of conductor taps joined to branch circuit conductors. At end of run, branch circuit conductors may terminate on receptacle screw terminals. Quick make, clamp, or push-in type terminations may not be used to make connections to devices.

Position all splices in pull boxes and junction boxes of adequate volume so they are accessible from the removable cover side of the box.

Conductors for signal systems shall be continuous (without splice) and shall be terminated on terminal strips or terminate in a manner approved by the system's manufacturer.

All neutrals and ground wires in panels shall be labeled with cloth wire markers to indicate the circuits being served.

Pull conductors simultaneously where more than one is being installed in same raceway.

Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation. After conductors have been pulled, clean exposed conductors and surrounding area to remove all evidence of the use of pulling compound.

Use pulling means including fish tape, cable, rope and basket weave wire/cable grips that will not damage cables or raceway.

Keep conductor splices to a minimum.

Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

Use splice and tap connectors that are compatible with conductor material.

Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A and B.

WIRING CONNECTIONS AND TERMINATIONS

Splices shall be permitted on conductors up to #4 AWG. No splices shall be permitted on conductor #3 AWG and larger without specific approval in writing by the A-E. Splices shall be made in accessible junction boxes; no splices shall be made in conduit bodies.

Splices, taps, and attachments of fittings and lugs shall be electrically and mechanically secure. Connectors and lugs shall be proper size and labeled as suitable for the number and type of conductors joined.

Solid conductors, namely those sized #10 and #12 AWG copper shall be spliced or tapped only by the use of Ideal "Wing-Nuts" or "Wire Nuts", Buchanan's "B-Cap" or 3M Co.'s "Scotchlox" connectors. "Sta-Kon" or other permanent type crimp connectors shall not be used.

Self-stripping electrical pigtail and tap connectors shall not be used.

Stranded conductors, namely #8 AWG to #4 AWG, shall be spliced or tapped by approved mechanical connectors. Insulation for splices or taps shall be obtained by the use of Listed insulating covers designed for use with the particular connector. Quality of insulation at splices shall equal that of the conductor insulation in terms of temperature resistance, covering ability and durability.

Conductors, in all cases, shall be continuous from outlet to outlet, and no splicing shall be made except within outlet or junction boxes, troughs, and gutters. No splices shall be permitted in panel enclosures, disconnects or utilization equipment.

Lugs for conductors #8 through #4 AWG shall be copper, with a direct acting screw. Where permitted, lugs for conductors #3 AWG and larger shall be copper, applied directly to the cable by hydraulic pressure. Lugs shall not be split bolt or screw types.

Tape, where used, shall be made using special oil resistant vinyl plastic tape that is Listed, rated 105° C.

Splices or taps in grounding conductors (where permitted) in sizes #8 AWG and larger shall be by means of exothermic welding and termination shall be by means of approved grounding connectors. As an alternate, connectors using hydraulic compression tools may be used as a contractor selection option. Solder shall not be used as a means of joining grounding conductors.

Thoroughly clean wires before installing lugs and connectors.

Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

Terminate spare conductors with electrical tape.

FIELD QUALITY CONTROL

Prior to energizing circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to insure requirements are fulfilled. Provide additional testing as directed by the A-E in accordance with Section 260800, *TESTING AND PLACING IN SERVICE*.

Prior to energizing circuitry, test wires and cables for electrical continuity and for short circuits. Verify proper phasing connections.

Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION 260519

SECTION 260526 - GROUNDING

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, grounding rods, and bonding jumpers whose products are Listed and Labeled for their intended usage.

Codes and Standards:

Electrical Code Compliance: Comply with applicable State electrical code requirements and the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment. Refer to NEC Table 250.66 “Grounding Electrode Conductor for Alternating Current Systems” pertaining to services and separately derived systems.

Testing Laboratory Compliance: Comply with applicable requirements of UL Standards No.'s 467, "Electrical Grounding and Bonding Equipment," and 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products that are Listed and Labeled for their intended usage.

IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

PART 2 - PRODUCTS

GROUNDING AND BONDING SYSTEMS

Materials and Components:

General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated, assemble materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding rods, bonding jumpers, service arresters, and additional accessories as needed for a complete installation. Where more than one type component product meets indicated requirements, selection is Contractor's option. Where materials or components are not indicated, provide products that comply with NEC and UL requirements and with established industry standards for those applications indicated.

Conductors: Unless otherwise indicated, provide equipment grounding conductors in all conduit and wiring systems. Grounding conductors shall be insulated by the same type insulation as the ungrounded conductors and sized in accordance with NEC Table 250.122 unless otherwise specified.

Bonding Connectors, Terminals and Clamps: Provide electrical bonding connectors, terminals, lugs and clamps as recommended by bonding connector, terminal and clamp manufacturers for indicated applications.

Hardware: Provide hardware for all grounding and bonding applications that consist of Type 300 series stainless steel, silicon bronze or brass. Hardware used for connections to enclosures shall include flat washers and split lock washers.

Electrical Grounding Connection Accessories: Provide electrical insulating tape, bonding straps, as recommended by accessories manufacturers for type service indicated.

PART 3 - EXECUTION

EXAMINATION

Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify A-E in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

General: Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure that products comply with requirements.

Install grounding systems as designed and submit certified test report on grounding system.

Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and cold water systems.

Provide a separate, insulated equipment grounding conductor from each device to ground buses in panelboards. Terminate each end on a grounding lug, bus, or insulated grounding bushing.

Provide separate insulated equipment grounding conductor, size to be determined from NEC Table 250.122, for each circuit and in each conduit run. The grounding conductor shall be attached by means of a dedicated green screw to a common point in each junction box, cabinet, device box, enclosure, or utilization equipment to which it runs or through which it passes. Grounding methods depending on the continuity of electrical raceway, clips, or mounting screws are not acceptable. This grounding requirement will be rigidly enforced.

Provide an insulated bonding bushing on all panelboard feeders. Terminate feeder equipment grounding conductor by passing the conductor through the terminal of the insulated bonding bushing and then onward to terminate at the panel ground bus.

Provide an insulated bonding bushing at boxes, enclosures or cabinets with concentric, eccentric or over-sized knockouts. Terminate equipment grounding conductor by passing the conductor through the terminal of the insulated bonding bushing and then onward to terminate at ground bus or lug.

Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed.

Install clamp-on connectors on clean metal contact surfaces to ensure electrical conductivity and circuit integrity.

END OF SECTION 260526

SECTION 260529 - SUPPORTING DEVICES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification section, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings required.

Codes and Standards:

NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.

Testing Laboratory Compliance: Provide electrical components that are Listed and Labeled.

ANSI Compliance: Comply with ANSI/MSS SP-69, Hangers and Supports – Selection and Application for selecting electrical supporting devices.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve and seal.

PART 2 - PRODUCTS

MANUFACTURED SUPPORTING DEVICES

General: Provide supporting devices as herein specified which comply with manufacturer's standard materials, design and constructed in accordance with published product information and as required for complete installation. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.

Supports: Provide supporting devices of types, sizes and materials indicated that have the following construction features:

Clevis Hangers: For supporting large rigid metal conduit hangers shall be steel with finish appropriate for application and 1/2" diameter hole for round steel rod. Approximate weight is 54 pounds per 100 units.

Reducing Couplings: Steel rod reducing coupling shall be 1/2", 3/8" or ¼" x 5/8" steel, with finish appropriate for application.

C-Clamps: C-clamps shall be ductile iron, with finish appropriate for application and 1/2", 3/8" or ¼" rod size. Approximate weight is 50 pounds per 100 units.

I-Beam Clamps: I-beam clamps shall be steel, with finish appropriate for application. 1-1/4" x 3/16" stock with 3/8" cross bolt. Flange width shall be 2". Approximate weight is 52 pounds per 100 units.

Conduit Hangers: Hangers shall be galvanized steel used for supporting conduit up to 2". Weight varies with conduit size, up to 25 pounds per 100 units for 2" trade size.

One-Hole Conduit Straps: One hole conduit straps used for supporting 1/2" conduit (where such is permitted) and 3/4" conduit, shall be galvanized steel. Approximate weight is 7 pounds per 100 units.

Two-Hole Conduit Straps: Two hole conduit straps, used for supporting conduit larger than 3/4", shall be galvanized steel. Weight varies with conduit size.

Hexagon Nuts: For 1/2", 3/8" or ¼" rod sizes, nuts shall be galvanized steel.

Round Steel Rod: Use black steel for 1/2", 3/8" or ¼" diameter rod.

Anchors: Provide anchors of types, sizes and materials indicated, with the following construction features:

Lead Expansion Anchors: 1/2", approximately 38 pounds per 100 units.

Toggle Bolts: Springhead type, 3/16" x 4", approximately 5 pounds per 100 units.

Watertight Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals of types and sizes indicated. Wall and floor seals shall be suitable for sealing around conduit, pipe, or tubing passing through concrete walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

U-Channel Strut Systems: Provide U-channel strut system for supporting electrical equipment and conduit where runs of more than two conduit must be supported from overhead structure. System shall be 12-gage minimum hot-dip galvanized steel of types and sizes indicated. Use 1 1/2" deep channel to support conduit larger than 1 1/2" trade diameter. Furnish with the following fittings that mate and match with U-channel:

Channel hangers

End caps

Beam clamps

Wiring studs

Thinwall conduit clamps

Rigid conduit clamps

Conduit hangers

U-bolts

FABRICATED SUPPORTING DEVICES

Pipe Sleeves: Provide pipe sleeves as follows:

Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

Sleeve Seals: Provide sleeves for piping which penetrates foundation walls below grade, or exterior walls. Caulk between sleeve and pipe with non-toxic, UL classified caulking material to ensure watertight seal.

PART 3 - EXECUTION

INSTALLATION OF SUPPORTING DEVICES

Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

Install hangers, supports, clamps and attachments to support conduit properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacings indicated and in compliance with NEC requirements.

Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form water tight seal.

END OF SECTION 260529

SECTION 260533 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical identification products, of types required.

Codes and Standards:

NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

UL Compliance: Comply with applicable requirements of UL Std. 969, "Marking and Labeling Systems," pertaining to electrical identification systems.

NEMA Compliance: Comply with applicable requirements of NEMA Std. No's. WC-1 and WC-2 pertaining to identification of power and control conductors.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on electrical identification materials and products.

Label Wording: Submit exact wording for approval prior to the construction of laminated nameplates or specialized signs. Submittal shall show both proposed wording and physical layout of each label, including mounting holes.

PART 2 - PRODUCTS

ELECTRICAL IDENTIFICATION MATERIALS

General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

Engraved Plastic-Laminate Signs:

General: Provide engraving stock melamine plastic laminate, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated or as required to properly identify items installed under this division.

Color scheme shall be as indicated herein or on the Drawings. Signs shall be punched for mechanical fastening.

Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.

Fasteners: Self-threading stainless steel screws.

Color-Coded Plastic Tape:

General: Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils. thick by 1-1/2" wide. Tape shall be listed for use at 105°C. or the temperature rating of the conductors to be marked, whichever is higher.

Cable/Conductor Identification Bands:

General: Provide pre-numbered or pre-lettered manufacturer's standard cloth self-adhesive cable/conductor markers of wrap-around type. Printing shall show circuit identification by indicating panel designation and circuit number.

LETTERING AND GRAPHICS

General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment.

WIRE COLOR CODE SCHEDULE

Where more than one nominal voltage system exists within a single facility, a schedule of conductor color codes shall be posted at each panelboard that is installed, relocated, renovated, or otherwise modified. The schedule, meeting the requirements of NEC 210.5(C) for branch circuit panelboards, shall be permitted to be either a plastic laminate sign or a printed label with permanent self-adhesive containing the information given in Section 260519, *SECONDARY VOLTAGE WIRES AND CABLES*. The label shall be installed so that it is clearly visible with the panelboard cover removed but with any shields or protective barriers in place. The label shall be installed after the installation of all conductors so that it may be located in an un-obscured location.

PART 3 - EXECUTION

APPLICATION AND INSTALLATION

General Installation Requirements:

Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC.

Coordination: Where identification is to be applied to surfaces that require finish, install identification after completion of painting.

Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

Conduit and Box Identification:

General: Apply color-coded identification to match system color code on electrical conduit and junction boxes in accordance with the following:

All empty conduit runs and conduit with conductors for future use shall be identified for such use; identification shall indicate where such conductors or empty conduct terminates. Identification shall be by tags attached to the pull cord or spare conductors. Each end of the pull cord shall be identified.

All outlet boxes, junction boxes and pull boxes, either exposed or concealed, shall have their covers and exterior visible surfaces painted with the field colors described in this section. Boxes shall also be marked to indicate the panelboard and circuit number(s) of the circuits contained within. Lettering may be by hand for concealed or non-public locations only. Machine printed labels are to be used to identify boxes where such are permitted to appear in areas accessible by the public; embossed type plastic labels are not acceptable for use on this project. Where hand produced marking is permitted, the lettering shall be made with waterproof ink.

Equipment/System Identification:

General: Install an engraved plastic laminate sign on each major unit of electrical equipment on project. Such equipment includes central or master unit of each electrical system including communication, control, and signal systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, 1/2" high lettering, on 1-1/2" high sign (2" high where 2 lines are required), white lettering in field color as indicated below. Provide text matching terminology and numbering of the Contract Documents and shop drawings.

Field Colors shall be the following:

Blue surface with white core for 120/208 Volt equipment.
Black surface with white core for 277/480 Volt equipment.
Bright red surface with white core for all equipment related to fire alarm system.
Dark red (burgundy) surface with white core for all equipment related to security.
Green surface with white core for all equipment related to emergency systems.
Orange surface with white core for all equipment related to telephone systems.
Brown surface with white core for all equipment related to data systems.
White surface with black core for all equipment related to paging systems.
Purple surface with white core for all equipment related to TV systems.

Provide Signs for Each Unit of the Following Categories of Electrical Work:

Disconnect or safety switches

Cable/Conductor Identification (Low Voltage):

General: Apply cable/conductor identification, including feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

Optional Identification and Warnings:

General: Install self adhesive plastic signs or similar equivalent identification wherever reasonably required to prevent misuse by unauthorized personnel or to ensure safe and efficient operation and maintenance of electrical systems, electrically connected mechanical systems, and general systems and equipment. Install self-adhesive plastic signs or similar equivalent identification giving instruction or warnings on switches, outlets, controls, or devices where instructions or explanations are needed. Provide plasticized tags with clearly written messages adequate for intended purposes.

END OF SECTION 260533

SECTION 260534 - RACEWAYS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products are Listed and Labeled.

Codes and Standards:

NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to raceways.

Testing Laboratory Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components that have been Listed and Labeled.

NEC Compliance: Comply with applicable requirements of the latest edition of the NEC pertaining to construction and installation of raceway systems.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

METAL CONDUIT AND TUBING

General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each use indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements as stated herein while complying with applicable portions of NEC for raceways.

Rigid Metal Conduit (RMC): Provide rigid steel, zinc-coated, threaded type conforming to ANSI C80.1 and UL 6. Provide zinc coating fused to inside and outside walls.

Electrical Metallic Tubing (EMT): Provide electrical metallic conduit conforming to ANSI C80.3 and UL 797.

Flexible Metal Conduit (FMC): Provide steel flexible metal conduit conforming to UL 1. Conduit shall be formed from continuous length of spirally wound, interlocked zinc-coated strip steel.

Liquid-Tight Flexible Metal Conduit (LFMC): Provide flexible liquid-tight metal conduit constructed of single strip, flexible, continuous, interlocked, and double-wrapped steel. Inside and outside shall be galvanized; conduit shall be coated with liquid-tight jacket of flexible polyvinyl chloride (PVC).

Rigid Metal Conduit Fittings: Provide cast malleable iron, galvanized or cadmium plated.

Use Type 1 fittings for raintight connections.
Use Type 2 fittings for concrete tight connections.

Conduit Locknuts: Provide case-hardened steel locknuts for use on threaded raceway.

Conduit Bushings:

Insulated: Provide Listed and Labeled, threaded, thermosetting plastic bushings at each end of all threaded raceway. Provide grounding type if same is indicated elsewhere.

Grounding (bonding type): Provide Listed and Labeled, threaded, insulated throat, bonding type bushings. Provide steel frame bushings for use on ferrous raceway. Provide bushings with tin-plated copper grounding saddle sized to accept grounding conductor size as indicated on the Drawings. Where grounding conductors are oversized, provide separate copper grounding lugs that are appropriately sized.

Flexible Metal Conduit Fittings: Provide steel conduit fittings for use with flexible steel conduit of threadless hinged clamp type. All flexible metal conduit fittings shall be Listed as suitable for grounding.

Straight Terminal Connectors: Provide insulated throat type, one piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with steel locknut.

45° or 90° Terminal Angle Connectors: Provide steel insulated throat type, two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with steel locknut.

Liquid-Tight Flexible Metal Conduit Fittings: Type 1, Class 3, Style G. Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat and steel locknut. All liquid tight flexible metal conduit fittings shall be Listed as suitable for grounding.

EMT Fittings:

EMT Conduit Couplings: Cadmium plated steel, dual compression type with two (2) hexagon compression fittings. Fittings that can not be tightened with an open-end wrench of the appropriate size are not acceptable.

EMT Conduit Connectors: Cadmium plated steel, insulated throat, compression type with hexagon compression fitting and steel locknut. Fittings that can not be tightened with an open-end wrench of the appropriate size are not acceptable.

Unacceptable fitting types: Pot metal, set screw, and indenter type fittings, or connectors that do not have insulated throats, are not acceptable for use on this project.

Conduit Bodies: Provide galvanized steel conduit bodies of types, shapes and sizes as required to fulfill job and NEC requirements. Conduit bodies shall be constructed with threaded conduit entrance ends, removable covers, either cast or of galvanized steel and corrosion-resistant screws.

Metallic Conduit, and Tubing Accessories: Provide metallic conduit and tubing accessories of types, sizes, and materials, complying with manufacturer's published product information, which mate and match conduit and tubing.

NONMETALLIC CONDUIT

General: Provide nonmetallic conduit and fittings of types, sizes and weights only where indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements that comply with provisions of NEC for raceways.

Rigid Polyvinyl Chloride Conduit (PVC):

Schedule 40, 90°C., Listed and Labeled, conforming to NEMA TC-2 for direct burial, encasement in concrete, use in sunlight, or normal above ground use, and in conformity with NEC Article 352.

PART 3 - EXECUTION

INSPECTION

Examine areas and conditions under which raceways are to be installed, and substrate that will support raceways. Notify A-E in writing of conditions detrimental to proper completion of the Work. Do not proceed with work until unsatisfactory conditions have been corrected.

SELECTION OF RACEWAY AND SIZE OF RACEWAY SYSTEM

General: Install concealed raceway system in new construction work, either in walls or above hung ceilings.

Do not route raceway below slabs unless such routing is specifically indicated on the Drawings.

Do not use surface metal raceway unless such use is specifically indicated on the Drawings.

Conduit Installation: Unless otherwise indicated on the Drawings, provide rigid steel zinc-coated conduit (RMC) where embedded in concrete, masonry, earth, or installed outdoors. Follow minimum requirements in other areas as follows:

Steel zinc-coated EMT may be installed in all areas except where specifically indicated otherwise in the Drawings or under the conditions of use listed below:

- Where it will be installed in exterior walls.
- Where it will be installed outdoors, in concrete or in direct contact with the earth.
- Where it will be subject to physical damage.
- Where it will be installed lower than four (4) feet from finished floor in areas where exposed to possible damage from area use activities.
- Where it will be subject to corrosive influence.
- Where it will be installed indoors in wet or damp locations.
- Where trade size is larger than 2".

Any of the above use conditions may be overridden by the Drawings.

Avoid use of dissimilar metals throughout system to reduce the possibility of galvanic action. Where dissimilar metals must be in contact, coat surfaces with corrosion inhibiting compound before assembling.

Use liquid-tight flexible metal conduit (LFMC) only where specifically indicated on the Drawings or where subjected to one or more of the following conditions:

- Flexible connection in an exterior location.
- Final 18" connection to motors.
- Equipment subject to movement or vibration.

Do not use PVC raceway unless such use is specifically indicated on the Drawings. Where PVC is permitted it must be installed in accordance with the following:

Where underground raceways turn up into pull boxes equipment, cabinets or poles, the 90° and/or similar fittings and stub-ups shall be rigid steel conduit grounded by use of bonding bushings connected to the equipment grounding conductor.

Provide minimum 3" concrete encasement for all underground routed PVC conduit. This shall not apply to underground raceways used for branch circuits.

Use Flexible Metal Conduit (FMC) only for final connections to light fixtures and utilization equipment. Any other use shall be limited to applications where specifically indicated on the Drawings

Flexible Metal Conduit may not be used to interconnect device or junction boxes, utilization equipment, fixtures.

Flexible Metal Conduit length shall not exceed six feet.

Size raceway and raceway systems as follows:

Size raceway to meet NEC requirements, or as indicated on the Drawings, whichever size is larger.

For underground use external to the building foundation no raceway smaller than 3/4 inch trade size shall be installed.

INSTALLATION OF RACEWAY SYSTEMS

General: Install raceways as indicated, in accordance with manufacturer's written installation instructions, and in compliance with the NEC and NECA's "Standards of Installation." Install raceway and related boxes and fittings plumb and level, ±2°. Maintain manufacturer's recommended clearances.

Fasten heavy wall conduit terminations in sheet metal enclosures by two locknuts, one inside and one outside of enclosure, and terminate with insulated bushing; terminate other conduit systems with connectors listed for the purpose and as described above.

Conduit couplers shall be steel threaded type in all locations where such use is possible. Otherwise use 3-piece union.

Conduits are not to cross pipe shafts or ventilating duct openings. Conduit is not to be routed in elevator shafts unless necessary to serve items within the shaft.

Keep conduits a minimum distance of 6" from parallel runs of hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water piping.

Support riser conduit at each floor level with clamp hangers.

Use of running threads at conduit joints and terminations is prohibited. Where required, use threaded nipples and 3-piece unions.

Support exposed conduit by use of hangers, clamps or clips Listed for the purpose. Support conduit on each side of bends and on spacing not to exceed following:

-
- Rigid Metal Conduits Up to 1": 8'-0".
- Rigid Metal Conduits 1-1/4" and Over: 10'-0".
- EMT Up to 1": 8'-0".
- EMT 1-1/4" and Over: 10'-0".

Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers Listed for the purpose. Requirements for exposed conduits also apply to conduits installed in space above hung ceilings.

Concealed Conduits:

- Metallic raceways installed underground, in floors below grade (where permitted), or outside are to have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure a water tight joint.
- For floors-on-grade (where permitted), install conduits under crushed rock and concrete slabs.
- Install underground conduits 24" below finished grade (24" cover) as a minimum or as otherwise indicated on the Drawings if a greater depth is shown.

Exposed Conduits:

- Install conduits in a manner so as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.
- Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.
- Install exposed conduit work as not to interfere with ceiling inserts, lights or ventilation ducts or outlets. Coordinate conduit installation with other trades as required.
- Install exposed conduit directly on structure using two hole straps. Provide offsets at all boxes and as required to avoid exiting utilities.
- Conduits installed on interior of exterior walls shall be spaced off the wall surface a minimum of ¼ inch with appropriate straps.

Run conduits for outlets on waterproof walls exposed where indicated on the Drawings. Set anchors for supporting conduit on waterproof wall in waterproof cement. Requirements for exposed conduit also apply to conduits installed in space above hung ceilings.

Non-Metallic Raceway:

- Make solvent cemented joints in accordance with recommendations of manufacturer.
- Install PVC raceway in accordance with NEC.

All PVC conduit connections to PVC junction boxes shall be made with listed connectors, approved for the application.

Raceway Fittings: Install connectors, couplers, and related fittings as required for a complete raceway system.

Install insulated bushings for terminating all types of raceway where termination is not made with an insulated throat connector.

Where concentric, eccentric or over-sized knockouts are encountered, a grounding-type insulated bushing shall be provided. Bushing shall be connected to the equipment grounding conductor.

Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, and plugs are to be constructed from steel and specifically designed and Listed for their particular application.

Coordinate with other work including wires/cables, boxes, and panel work, as necessary to interface installation of electrical raceways and components with other work.

Mechanically fasten together metal conduits, enclosures, and other components comprising raceway system to form a continuous electrical conductor. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly.

Raceway must be installed as a complete system prior to the installation of cables, conductors, or pull wires into any part of the systems.

Install miscellaneous fittings such as reducers, chase nipples, 3-piece unions, and plugs that have been specifically designed and manufactured for their particular application. Install expansion fittings in raceways every 200' linear run maximum and wherever structural expansion joints are crossed.

Use roughing-in dimensions of electrically supplied utilization equipment furnished by supplier or by other divisions as appropriate. Set conduit and boxes for connection to units only after receiving review of dimensions and after verification of location with other trades.

> Do not set final connections for fixtures and/or utilization equipment until connection points and requirements are accurately known. The Contractor is responsible for the relocation of mis-located connection points as required to match equipment at no additional cost.

Cut conduits straight, properly ream. Threads shall be cut into heavy wall conduit using equipment designed for the purpose.

Make changes in direction of raceway run by means of proper field bends or with proper fittings, supplied by raceway manufacturer.

Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.

Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported for lengths in excess of the maximum support distance as previously specified. Raceways may not be used to support other raceways or other items of equipment.

Arrange conduit to maintain headroom and present a neat appearance.

Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

Group raceway in parallel runs where three (3) or more raceway are routed together. Use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25% additional conduit.

Do not fasten and/or hang conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used during construction for temporary conduit support.

Bring conduit to the shoulder of fittings and couplings and fasten securely. All raceway shall be cut to proper length so ends fit accurately in connectors or couplers.

Use conduit hubs for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet locations.

Use conduit bodies to make sharp changes in direction, as around beams.

Use hydraulic one-shot conduit bender for all field bends in conduit. All field made conduit bends shall meet minimum bending radius requirements of the NEC. Bends in metallic conduit shall be made while "cold". Factory made conduit sections may be used in lieu of field made bends for conduit larger than 2".

Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

Where conduit penetrates fire rated partitions, provide penetration protection in accordance with the UL through-penetration detail indicated on the Drawings for the type of partition and conduit involved. All instructions furnished with firestopping materials shall be followed explicitly.

Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket. All pitch pockets shall be absolutely water tight; once conduit has been routed thought a pitch pocket the water integrity of the pitch pocket is the responsibility of the Division 26-28 Contractor.

Combining of circuits into raceway systems other than indicated on Drawings shall not be permitted.

Bolts, clamps, screws and expansion bolts shall be used in securing conduit, equipment, etc. Holes for lead shields or other anchors shall be the size recommended by the fastener manufacturer and shall be completely covered by the mounted item. Holes used for support of conduit on brick or block walls shall be located in mortar joints where such location is possible.

Provide nylon pull string in empty conduits where indicated, including conduit placed for telephone and data use. Conduit installed but left empty (with pull string) shall be tested with a ball mandrel. Clear any conduit that rejects ball mandrel. Any costs involved for restoration of conduit and surrounding surfaces to original condition are the responsibility of the Contractor.

INSTALLATION OF SURFACE RACEWAY AND WIREWAYS

General: Use surface raceway or wireway only where specifically permitted in the Drawings.

Mechanically assemble metal enclosures and raceways for conductors to form continuous electrical conductor and connect to electrical boxes, fittings, and cabinets as to provide effective electrical continuity and rigid mechanical assembly. Use flat-head screws to fasten channel to surfaces; mount plumb and level. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

Maintain grounding continuity between raceway components to provide a continuous grounding path.

Avoid use of dissimilar metals throughout system to reduce the possibility of galvanic action. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembly.

Install expansion fittings in all raceways and wireways wherever structural expansion joints are crossed.

Use boxes as supplied by raceway or wireway manufacturer wherever junction, pull or devices boxes are required. Standard electrical "handy" boxes, *etc*. shall not be permitted for use with surface raceway installations.

END OF SECTION 260534

SECTION 260535 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products are Listed and Labeled.

Codes and Standards:

NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

Testing Laboratory Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings that are Listed and Labeled.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on electrical boxes and fittings.

PART 2 - PRODUCTS

FABRICATED MATERIALS

Aluminum products are not acceptable for use on the project.

Outlet Boxes: Provide galvanized coated flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable or conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes for attachment of grounding conductor and cover plate or device attachment fittings.

Provide waterproof outlet boxes where box is installed in an outdoor location or in a wet location as defined by the NEC.

Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes. Supplied items shall be compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.

Device Boxes: Provide galvanized coated flat rolled sheet-steel device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Unless otherwise specified device boxes shall be 4" square by 2 1/8” deep, flush mounted, and furnished with suitable plaster ring for the type devices to be used and of a depth to match the type of construction involved. Device boxes shall have ¾" knockout openings in bottom and ends, and with threaded screw holes in the rear for attachment of a grounding conductor. All fasteners shall have a corrosion resistant finish.

Where more than two devices are ganged together at a single location provide gangable device boxes with suitable partitions, conduit knockouts and attachment hardware.

Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.

Where device boxes are surface mounted (as may permitted elsewhere) use cast steel type 'FS' boxes. Raintight device boxes shall have threaded conduit holes for the attachment of electrical conduit, cast-metal face plates with spring-hinged watertight caps suitable configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners. Boxes provided under this section shall have a threaded internal grounding conductor attachment point.

Device boxes exposed to outdoor or wet locations shall be flush mounted and shall be equipped with cast steel covers that are designed to exclude water when closed.

Provide covers that are suitable for use in wet location with device attached if such use is indicated on the Drawings.

Where flush mounting is not possible or not practicable due to the location of the device, provide surface mounted cast steel type 'FS' boxes as described elsewhere.

Junction boxes with no more than 4 entries of ¾" conduit containing conductors no larger than #12 may be 4" square by 2 1/8" deep with ¾" knockouts, threaded hole for connection of grounding conductor and threaded holes for the attachment of a blank cover plate. Provide suitable blank cover plate. Box extensions shall not be used to obtain more volume in 4" square junction boxes.

If box volume is not sufficient, the contractor may, as a code compliance option, may use 4 11/16" square by 2 1/8" deep boxes with ¾" knockouts, threaded hole for connection of grounding conductor and threaded hoses for the attachment of a blank cover plate. Provide suitable blank cover plate. Box extensions shall not be used to obtain more volume in 4 11/16" square junction boxes.

Use fabricated junction boxes as described below if box volumes that can be obtained by the use of 4" square or 4 11/16" square boxes are not sufficient to meet NEC minimum volume requirements.

Junction and Pull Boxes: Provide as required galvanized code-gage sheet steel junction and pull boxes, no knockouts, Listed, with screw-on covers. Types, shapes, and sizes of junction and pull boxes shall be suitable for each respective location and installation. Boxes shall have welded seams and shall be equipped with stainless fastening hardware. Provide steel barriers in boxes with multiple feeder circuits.

Auxiliary Gutters: Construct as required in accordance with UL 870, with Listed and Labeled components.

Construction: 16-gage galvanized sheet metal parts for 4" x 4" to 6" x 6" sections, and 14-gage parts for 8" x 8" and larger sections. Provide auxiliary gutters with no knockouts.

Finish: Provide 14-gage and 16-gage galvanized sheet metal parts. Plate hardware to prevent corrosion.

In outdoor or wet locations provide auxiliary gutters that are NEMA 3R. Do not use gaskets that can rip or tear during installation, or would otherwise compromise raintight capability of the gutter.

Do not use cover screws that will protrude into the trough area and damage wire insulation.

Size of device, outlet, junction, pull boxes, gutters, and similar components shall be as required to match the number of devices and/or conductors contained within as based on the requirements of NEC Article 314.16.

Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit insulated bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

PART 3 - EXECUTION

INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

General: Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

Provide weatherproof boxes and fittings for interior and exterior locations that are exposed to weather or moisture. Weatherproof boxes must be Listed and Labeled for use in wet locations.

Provide knockout closures to cap unused knockout holes where blanks have been removed.

Install electrical boxes and similar items only in those locations that ensure accessibility to enclosed electrical wiring.

Avoid installing boxes back-to-back in walls. Provide not less than 6" separation in non-rated partitions. Provide 24" minimum horizontal separation in fire-rated partitions or in acoustic rated walls.

Position recessed outlet or device boxes in walls or ceilings accurately to allow for surface finish thickness. Where the surface material or covering is combustible the front edge of the plaster ring (or box) shall be flush (- 0",+1/32") with the finished surface. Where the wall or ceiling material is non-combustible, the front edge of the plaster ring (or box) may be recessed into the wall no further than 3/16". The maximum gap between the edge of an installed box/plaster ring combination shall not exceed 1/8". **These requirements will be rigidly enforced.**

Do not use round boxes unless noted otherwise on the Drawings.

Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. All boxes shall be supported independently of conduit.

Provide electrical connections for installed boxes.

Electrical box locations indicated on Drawings are approximate unless dimensioned. Verify location of outlets prior to rough-in. Coordinate exact locations with the work of other Divisions. Mis-located outlets and/or devices shall be relocated upon instruction from Owner's representative at no additional cost.

Locate and install to maintain headroom and to present a neat appearance.

Use multiple gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems. Provide barriers to separate adjacent devices where the voltage is greater than 150 Volts between the devices.

Install boxes in walls without damaging wall insulation or fire proofing.

Position outlets to locate lighting fixtures and/or luminaries as indicated on Drawings. Boxes are to be positioned plum and vertical, $\pm$ 2°.

Align wall mounted outlet boxes for switches, thermostats, and similar devices.

Subsequent to installation of boxes, protect boxes from construction debris and damage.

GROUNDING

Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

END OF SECTION 260535

SECTION 260593 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, solder/fluxes, and cable ties, whose products are Listed.

Codes and Standards:

NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches.

Testing Laboratory Compliance: Comply with UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials that are Listed and Labeled.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on electrical connections for equipment products and materials.

PART 2 - PRODUCTS

MATERIALS AND COMPONENTS

General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

Metal Conduit, Tubing and Fittings:

General: Provide metal conduit, tubing and fittings of types, grades, and sizes indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Section 260534, *RACEWAYS*, and in accordance with the following listing of metal conduit, tubing and fittings:

Rigid steel conduit

Rigid metal conduit fittings

Electrical metallic tubing

EMT fittings

Flexible metal conduit

Flexible metal conduit fittings

Liquid-tight flexible metal conduit

Liquid-tight flexible metal conduit fittings

Wires, Cables, and Connectors:

General: Provide wires, cables, and connectors complying with Section 260519, *SECONDARY VOLTAGE WIRES AND CABLES*.

Wires/Cables: Unless otherwise indicated, provide conductors for electrical connections that match, including sizes and ratings, of wires/cables that are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 68° F.

Connectors and Terminals: Provide copper electrical connectors and terminals that mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications. **Aluminum conducting components are not acceptable for use on this project.**

Electrical Connection Accessories: Provide electrical insulating tape, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

INSPECTION

Inspect area and conditions under which electrical connections for equipment are to be installed and notify A-E in writing of conditions detrimental to proper completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

INSTALLATION OF ELECTRICAL CONNECTIONS

Install electrical connections as indicated in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA'S "Standard of Installation" to ensure that products fulfill requirements.

Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating than electrical insulation rating of those conductors being spliced.

Prepare cables and wires by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes that will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance. Leave a minimum of 6" of excess spare conductor at each termination.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torque requirements are not available, tighten connectors and terminals to comply with torque values contained in UL 486A.

Provide flexible connections to equipment as follows:

Provide Flexible Metal Conduit (FMC) for connection of electrical equipment where subject to movement and vibration or as otherwise required by the Specifications or on the Drawings.

Provide metal Liquidtight Flexible Metal Conduit (LFMC) for equipment in exterior locations, wet locations, or in other locations where so indicated on the Drawings.

Fasten identification markers to each electrical power supply wire/cable conductor that indicates their voltage, phase and feeder number in accordance with Section 260533, *ELECTRICAL IDENTIFICATION*. Affix markers on each terminal conductor, as close as possible to the point of connection.

FIELD QUALITY CONTROL

Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION 260593

SECTION 260800 - TESTING AND PLACING IN SERVICE

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of contract, including general and supplementary conditions and Division-1 Specification Sections, apply to work of this Section.

WORK INCLUDED

Provide all material, equipment, labor and technical supervision to perform and complete the electrical acceptance tests in accordance with the requirements of this section for equipment installed as the Work of this contract. Notify A-E at least four (4) working days in advance of tests.

Perform Tests on the Following Equipment and/or in the following areas:

Cable Tests: Low Voltage (<600 Volt)
Overcurrent devices
Rotating Equipment

DEFINITIONS

Measure: To obtain the requested system information by use of suitable instruments and to record this information in the appropriate section of the test report.

Repaired: Material or equipment that has been brought to new condition, retested and made to pass all required tests.

QUALITY ASSURANCE

Perform tests to obtain required information in accordance with accepted industry procedures and/or in accordance with manufacturer's recommendations. Should manufacturer's recommendations conflict with these specifications, notify A-E. Do not proceed with tests until directed by A-E.

Material or equipment failing tests shall be repaired or replaced at the Contractor's expense.

The Contractor shall be responsible for all tests and for documentation of test data. Testing shall be performed by or under the immediate supervision of the Contractor.

DOCUMENTATION

Records of all tests and inspections, with complete data on all readings taken, shall be made and incorporated into a single report.

Five (5) bound copies of all test reports shall be submitted at the end of the test period. All required documentation of readings indicated above shall be submitted to the engineer prior to, and as one of the prerequisites for, final acceptance of the project.

PART 2 - PRODUCTS

The Contractor shall employ testing devices as required to accomplish specified testing herein and as described elsewhere in the Contract Documents.

Test Equipment Suitability: The test equipment used by the Contractor shall be suitable for the intended tests and shall comply with ANSI/NETA ATS-2009, Section 5.2.

Test Equipment Calibration: The test equipment used by the Contractor shall be suitable for the intended tests and shall comply with ANSI/NETA ATS-2009, Section 5.3.

PART 3 - EXECUTION

GENERAL

Check cable continuity and phase identification for each conductor used on the project. This includes service conductors, feeders, and branch circuit conductors. It is not required to document this test in the testing report required under this section.

Insulation testing: The insulation tests (megger tests) as specified in this Section are the minimum readings desired at an ambient temperature of 60° F and a low relative humidity.

Megger readings taken at other than ambient temperature of 60° F shall be corrected to 60° F.

When megger readings fall below the specified minimum values utilize recognized means to dry out the equipment. The method utilized by the Contractor must be in accordance with manufacturer's written instructions.

If drying is to be accomplished by applying an electric potential to a cable or piece of equipment, then, in no case (induced or direct) shall the voltage or current exceed the ampacity or the continuous rating of the equipment being dried.

CABLE TESTS

General: Disconnect each end of all cables from their associated equipment prior to the test.

Cables ≤ 600 Volt: Inspect all cable connections for workmanship and conformance with standard practice.

Perform the following tests:

Test cable insulation using a megger.

Perform megger tests between phases and between each conductor and ground with the other conductors and interlocked armor (if part of cable assembly) grounded.
Test other conductors in the same manner. The minimum acceptable megger reading for cables shall be 1 megohm (MΩ) for #6 AWG conductors and smaller and 250,000 ohms (Ω) for #4 AWG conductors and larger.

The Test Record Shall Include the Following:

Date of test.

Complete identification of the cable, including approximate length.

Temperature and weather conditions.

Type and description of test equipment.

Duration of test.

Megger reading data.

OVERCURRENT DEVICES

Operational Test Procedures for Circuit Breakers: Visually inspect and manually operate breakers through a minimum of three (3) open/close cycles. Check for correct alignment, freedom from binding and good contact. Check phase matching and phase rotation immediately prior to energizing of equipment.

ROTATING EQUIPMENT

During installation, inspect all rotating equipment for damage, moisture, alignment, proper lubrication, oil leaks, phase identification and cleanliness. Check proper rotation. Check and record motor speed (speeds for multi-speed motors).

Perform a megger test on all rotating equipment with the windings at ambient temperature. Dry and retest any machine not passing this test until it either passes or is found unsatisfactory.

For three phase motors, apply megger tests between all phases tied together and ground.

Maintain megger tests for one (1) minute or until the reading maintains a constant value for 15 seconds.
Final acceptance of rotating equipment will be made after the equipment is successfully energized during operational tests. Tests with each machine mechanically uncoupled (where reverse rotation could damage equipment) shall prove proper rotation, lubrication and alignment. The machine under test shall not have an excessive vibration.

The Test Record Shall Include the Following:

Complete identification of item of rotating equipment.

Values of megger tests.

Rotational speed of the equipment under test.

DOCUMENTATION

All tests specified shall be completely documented indicating time of day, date, temperature and all pertinent test information.

All required documentation of readings indicated above shall be submitted to the engineer prior to, and as one of the prerequisites for, final acceptance of the project.

TEST RESULTS

The Contractor shall send a letter to the engineer, certifying that the above testing has been performed. This shall be done at least four (4) days prior to final inspection.

At final inspection, the Contractor shall furnish instruments as required to demonstrate to the A-E that all testing requirements have been satisfied. All measurement instruments, labor, and materials associated with the testing, verification, and demonstration of results shall be provided without additional cost. The contractor shall provide ladders, hand tools, digital multimeters, meggers, two-way radios and other specific items required by the Engineer for the final inspection.

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 – GENERAL

RELATED DOCUMENTS

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

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of lighting control devices, of types and ratings required in this Section, whose products are Listed and Labeled for the purpose intended. Subject to compliance with requirements provide equipment equivalent to that provided by manufacturers listed in this Section.

- Wattstopper
- Novitas
- Sensor Switch
- Hubbell

Codes and Standards:

NEC Compliance: Comply with NEC requirements pertaining to lighting control devices.

Code of Federal Regulations Compliance: Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Include dimensions and data on features, components, and ratings for lighting control devices.

Samples: Provide samples of submitted occupancy sensors for color selection and evaluation of technical features if requested in writing by the A-E. If approved, the sample may be used on the project.

Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

Maintenance Data: For lighting control devices to include in maintenance manuals specified in Division 1.

Provide coverage pattern templates for each occupancy sensor type used as part of the project. Where requested by the Engineer, provide drawings that overlay the proposed coverage patterns. Provide summary of settings available for each sensor type. Submittal review shall include confirmation of settings to be applied for each sensor type used in project.

PART 2 – PRODUCTS

OCCUPANCY SENSORS

Manufacturers: Provide equipment equivalent to that provided one of the following manufacturers:

- Wattstopper
- Novitas
- Sensor Switch
- Hubbell

Sensors shall be provided with a single pole, isolated relay (30V AC/DC, 1A) for interface with building automation system. Relay and contact ratings shall be clearly indicated in submittal literature.

Wall Switch Occupancy Sensor: Provide a wall mounted, passive infrared occupancy sensor with a manual on/off switch. Switch to have 180° of coverage for a maximum of 300 square foot of desktop space. Digital time delay to be adjustable from 30 seconds to 30 minutes, with adjustable sensitivity from 20% to 100%, and programmable daylight override. Switch to be compatible with electronic ballasts and shall have 3 way switching capability with other similar devices. Switch to be rated at 800W @ 120V and 1,200W @ 277V. Provide vandal resistant, hard usage lens for sensor.

Dual Technology Ceiling Mounted Occupancy Sensor: Provide a 24 VAC ceiling mounted combination passive infrared and ultrasonic sensor. Coverage for normal desktop motion shall be 900 square feet at a 360° pattern. Digital time delay shall be adjustable from 15 seconds to 30 minutes with a self adjustable sensitivity that can be overridden. Provide sensor with an integral daylighting control interface. Provide number of compatible power modules to interconnect sensors to controlled loads.

Sensors shall be user-adjustable for the following alternative modes of operation:

Occupancy Mode: Sensor shall automatically energize controlled elements when the space becomes occupied and de-energize them when the space becomes unoccupied.

Vacancy Mode: Controlled elements shall be energized by manual occupant control when the space is occupied and de-energized by the sensor when the space becomes unoccupied.

Provide (Emergency Lighting Transfer Switch) suitable for use with auxiliary generator or inverter system to control branch circuit lighting loads up to 20A regardless of local switch position. The device consists of relay switching circuitry in a single, wall mounted enclosure. The relay control switch includes integral sensing circuitry that senses loss of power of an identified circuit. Once power loss is sensed it automatically switches to the emergency source. Unit shall be suitable for any type of light source at both 120V and 277V.

Unit shall meet applicable requirements of UL 924, Standard for Safety of Emergency Lighting and Power Equipment, UL 1008, Standard for Safety Transfer Switch Equipment and applicable NEC requirements.

Provide relay control switch in 9”W x 6”H x 3.5” D steel enclosure, UL listed for use in damp location. Provide enclosure with LED indicators that identify switch position.

Provide relay control switch with 45mA, 4 watt sensing circuit to monitor normal source. Provide auxiliary relay contacts as required to bypass dimming controls when used to control circuits served through a dimming system.

PART 3 – EXECUTION

INSTALLATION

Install equipment level and plumb and according to manufacturer's written instructions.

Mount lighting control devices according to manufacturer's written instructions and requirements in Section 260500, *BASIC ELECTRICAL REQUIREMENTS*.

Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

Spare Parts: Provide the following spare parts with the system, each individually packaged and labeled. For multi-building projects, calculate separately for each building:

Wall mounted occupancy sensors (each type)	4% of installed quantity
Ceiling mounted occupancy sensors (each type)	4% of installed quantity

Increase decimal quantities of spare parts to the next higher whole number. For example if a system has 20 wall mounted passive infrared sensors, provide 2 spare sensors.

CONTROL WIRING INSTALLATION

General: Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Section 260519, *SECONDARY VOLTAGE WIRES AND CABLES*, for low-voltage connections and for digital circuits.

Wiring Method: Install all wiring in raceway as specified in Section 260534, *RACEWAYS* and Section 260535, *ELECTRICAL BOXES AND FITTINGS*.

Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

IDENTIFICATION

Identify components and power and control wiring according to Section 260533, *ELECTRICAL IDENTIFICATION*.

FIELD QUALITY CONTROL

Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.

Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform continuity tests of circuits prior to installing devices. Perform operational tests according to manufacturer's written instructions. Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions. Test devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

CLEANING

Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

TESTING & DOCUMENTATION

Provide documentation for settings assigned for all occupancy sensors.

Verify proper operation of all equipment, including any specific features of the equipment. Provide all necessary components to properly demonstrate operation of equipment to engineer.

TRAINING

Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance.

Training Aid: Use the approved final version of maintenance manuals as a training aid.

Schedule training with Owner, through A-E, with at least seven days' advance notice.

WARRANTY PERIOD

Warranty period for occupancy sensors shall be one year, beginning upon acceptance of the installation by the Owner. Include up to three site visits within the first year, upon request by the Owner, to adjust light levels, make program changes, and adjust sensors and controls to suit actual conditions.

END OF SECTION 260923

SECTION 265000 - LIGHTING FIXTURES

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in the manufacture of interior lighting fixtures of types, sizes, and ratings required, whose products are Listed and Labeled.

Codes and Standards:

Electrical Code Compliance: Comply with applicable State building code requirements, the requirements of the authority having jurisdiction, and the NEC as applicable to installation and construction of lighting fixtures.

NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/No.'s LE 1 and LE 2 pertaining to lighting equipment. Comply with applicable requirements of NEMA Std. Pub No.'s 1B 4, 1B 5, and FA 1 pertaining to emergency lighting. Comply with NEMA Std. Pub. No.'s SH 5 and TT 1 pertaining to pole/standard construction materials, installation and pole hardware.

Testing Laboratory Compliance: Comply with UL standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide lighting fixtures and components that are Listed and Labeled.

ANSI Compliance: Provide lamp ballast which comply with ANSI C82.

NFPA Compliance: Comply with applicable requirements of NFPA 99, "Health Care Facilities" and NFPA 101, "Life Safety Code."

NC Code Compliance: Comply with applicable requirements of current NC Energy Code

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's product data and installation instructions on each type interior building lighting fixture and component. Include product data on lamps and ballasts used for each fixture type. Submit manufacturer's data from the ballast manufacturer that certifies compatibility for the lamps served. Include photometric data for each fixture type.

Shop Drawings: Submit layout drawings of interior lighting fixtures and their spatial relationship to each other. In addition, submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet. Submit details indicating compatibility with ceiling system and methods of support for each interior fixture type.

Maintenance Data: Submit maintenance data and parts list for each interior lighting fixture and accessory; including "trouble- shooting" maintenance guide. Include that data, product data, and shop drawings in a maintenance manual submitted in accordance with requirements of Division 1.

PART 2 - PRODUCTS

INTERIOR LIGHTING FIXTURES

General: Provide lighting fixtures of sizes, types and ratings indicated. Fixtures shall be supplied complete with all suspension accessories, canopies, housings, hickeys, sockets, starters, holders, reflectors, ballasts, louvers, frames, poles, hangers, standards, and any and all other items necessary to install fixtures.

Provide fixtures with accessories appropriate for all ceiling types into which the fixtures are placed. See architectural Drawings and Specifications to verify ceiling types, modules, or suspension systems appropriate to installation. Refer to the Fixture Schedule for specific fixture requirements.

LED FIXTURES

LED luminaires shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply) and integral controls as per this specification. All electrical components shall be RoHS compliant.

Luminaire shall be designed to operate at an average operating temperature of 25°C. The overall operating temperature range shall be -20°C to 50°C ambient.

Minimum operational life shall be minimum 50,000 hours at 70% light output (L70) when operated at the average operating temperature.

LED luminaire housing to have no visible welding, screws, springs, hooks, rivets, bare LED's or plastic supports. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply and circuit board for the luminaire shall be integral to the unit.

Individual LED's shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire. LED Boards shall be suitable for field maintenance and have with plug-in connectors. LED boards shall be upgradable.

LED Drivers: Provide solid state drivers that are modular and field serviceable, capable of operating lamp types indicated. Provide drivers meeting the following minimum requirements:

- UL Listed 8750, Sound Rated A.
- Lighting regulation: ±10% over design voltage range.
- Voltage range: ±10% nominal.
- Power factor: >0.90; THD: <20%.
- Operating range: -20°C to 50°C ambient.
- Built-in transient protection per ANSI/IEEE C64.41 2002, Category A.
- Must meet requirements of FCC 47 Part 15 (radiated RF).

Dimming: Driver shall be suitable for full-range dimming, where indicated on the Fixture Schedule. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, inaudible in 26 db environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment. Dimming range shall be 100% to 10% of rated lumen output with a smooth shut off function.

Drivers shall track evenly at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.
The electronics/power supply enclosure shall be internal to the luminaire and be accessible per UL requirements.

Surge Suppression: The luminaire shall include surge protection within the driver to withstand high repetition noise and other interference.

In Rush Current: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps of load, with a maximum value of 370 $amps^2$ – seconds.

RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions.

Electrical connections between normal power and driver must be modular utilizing a snap fit connector. All electrical components must be easily accessible after installation and be replaceable without removing the fixture from the ceiling.

The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.

The driver manufacturer's maximum case temperature shall be stated in the product submittal and shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.

Warranty: The manufacturer shall provide a single source, 5 year minimum limited warranty against loss of performance and defects in materials and workmanship for all components of the luminaire. Warranty is from the time of acceptance of the Luminaires. All warranty documentation shall be provided to customer prior to the first shipment. Provide manufacturer's warranty covering 5 years minimum on drivers from date of acceptance

EMERGENCY LIGHTING FIXTURES

General: Provide lighting fixtures, of sizes, types and ratings indicated complete with, but not limited to, housings, batteries, lamps, lamp holders, reflectors, energy-efficient ballasts, starters, and wiring.

Wiring: Provide wiring within fixtures for connection to branch circuit wiring as follows:

NEC Type SF-2 for 120 Volt, minimum No. 18 AWG.

Exit Fixtures - Non-battery Powered: Provide surface, wall, or ceiling mounted Light Emitting Diode (LED) type fixtures as indicated. Fixtures shall have selectable exit arrow directions. The arrow directions, where indicated on the Drawings, shall be selected to point as shown.

Legend Panels: Provide panels or other legend medium with permanent letters, minimum size to be: 6" high, 3/4" stroke. Letter color and background color shall be the same as the fixture indicated in the Fixture Schedule. Provide special wording on legend panels in lieu of "EXIT" where indicated in the Fixture Schedule.

Provide exit and emergency fixtures with pilot light to indicate the unit is connected to A.C. power. The battery shall have high rate charge pilot light, unless self-diagnostic type. Provide a test switch to simulate the operation of the unit upon loss of A.C. power by energizing the lamps from the battery. This simulation must also exercise the transfer relay.

Provide exit and emergency fixtures with manufacturer's three year warranty. The battery must have an additional two more years pro-rated warranty. Warranty shall start from the date of project final acceptance. Warranty shall be included in the contract document.

LIGHTING FIXTURE SCHEDULE

Refer to lighting fixture schedule on electrical plans. **These manufacturer's names and fixture series are not intended as a brand name specification**. Fixtures provided out of the Cooper Group, Lithonia Group, Hubbell Group, Thomas Industries or Williams/Infinity may be submitted for approval. This fixture schedule shall be used in conjunction with the graphic fixture schedule on the Drawings.

The dimensions for fixtures vary among manufacturers. The dimensions listed in this schedule are provided as a guide to demonstrate the design intent. These dimensions are not intended to restrict the use of fixtures that are otherwise equivalent to the fixtures listed as meeting the performance specifications herein. Where dimensions for submitted fixtures are not consistent with those listed in this schedule, the Contractor shall clearly indicate any features that are non-compliant with these specifications.

PART 3 - EXECUTION

EXAMINATION

Examine areas and conditions under which lighting fixtures are to be installed, and substrate for supporting lighting fixtures. Notify A-E in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

INSTALLATION OF INTERIOR LIGHTING FIXTURES

Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

Where fixtures are supported directly from an outlet box, provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by A-E.

Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surfaces.

Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.

Fasten fixtures securely to indicated structural supports; ensure that pendant fixtures are plumb and level. Provide individually mounted pendant fixtures longer than 2 feet with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum one inch vertical adjustment. Mount continuous rows of fixtures with an additional stem hanger greater than number of fixtures in the row.

LED lighting fixtures, related junction boxes, and conduit are to be supported directly from the building structure. Support fixture independently from each corner using ceiling grid gauge wire; use of the ceiling grid or wires supporting ceiling grid to support fixtures, junction boxes, or conduit is not permitted. Provide a screw at four corners to secure fixture to ceiling grid system.

Recessed can lighting fixtures, related junction boxes, and conduit are to be supported directly from the building structure. Support fixture independently from two opposing corners using ceiling grid gauge wire; use of the ceiling grid or wires supporting ceiling grid to support fixtures, junction boxes, or conduit is not permitted. Provide a screw at four corners of mounting bars to secure fixture to ceiling grid system.

Support surface mounted fixtures greater than 2 feet in length at two points in addition to the outlet box fixture stud.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B, and the National Electrical Code. Tap connections are permitted within fixtures that are mounted end-to-end and supplied with power from a single end.

Otherwise, no splices, other than those necessary for the connection of a single fixture, shall be made within a fixture enclosure.

INSTALLATION OF EMERGENCY LIGHTING FIXTURES

Install emergency lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

Coordinate with other electrical work as appropriate to properly interface installation of emergency lighting fixtures with other work.

Wall mounted fixtures shall be installed plumb and vertical. Fixtures shall be located as shown on the Drawings, mounted to fixture boxes or other suitable boxes with matching plaster rings as required by the type of construction. Where used over single doors, the fixture shall be centered in the door opening. Where used over double doors, the fixture shall be centered over either the center of the door or over the exit side of the door as indicated in the Drawings. Where emergency lighting is used at a door location and ceiling height is low, fixtures shall be mounted so that there is no conflict between the door swing and the fixture.

Ceiling mounted fixtures shall be supported from fixture boxes or other suitable boxes with matching plaster rings as required by the type of construction. Fixture boxes used to support ceiling mounted fixtures shall be supported directly by the building structure using threaded rod and appropriate hardware. Use of grid ceiling tile, grid support wires, or grid members for the support of emergency fixtures shall not be permitted.

FIELD QUALITY CONTROL

Replace defective and burned out lamps for a period of one year following approval of final inspection.

After approval of final inspection, replace lamps in interior lighting fixtures that are observed to be noticeably dimmed after Contractor's use and testing, as judged by Engineer.

Upon completion of installation of emergency lighting fixtures, and after building circuitry has been energized with normal power source, apply electrical energy to demonstrate capability and compliance with requirements. Test emergency lighting after units have been permanently installed and charged per manufacturer’s instructions, but no less than 24 hours. Batteries shall be tested for 90 minutes and meet the minimum illumination requirements of NFPA-101. Record battery voltage of each unit before and after test and submit to engineer for review. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

ADJUSTING AND CLEANING

Clean lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses.

Protect installed fixtures from damage during remainder of construction period.

GROUNDING

Provide equipment grounding connections for all interior lighting fixtures. Each interior lighting fixture shall be grounded by means of a separate insulated grounded conductor routed with the ungrounded conductor(s). The grounding conductor to each fixture shall terminate on a dedicated green screw within the fixture itself. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounds.

END OF SECTION 265000

SECTION 270528 – TELEPHONE/DATA RACEWAY SYSTEM

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

QUALITY ASSURANCE

Codes and Standards:

NEC Compliance: Comply with NEC as applicable to communication system materials and installations.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit manufacturer's data on terminal cabinet.

PART 2 - PRODUCTS

PART 3 - EXECUTION

INSTALLATION OF TELEPHONE /DATA RACEWAYS

Install telephone/data raceway system as indicated. Unless otherwise specified on the drawings all outlet locations receive a 1" EMT conduit run from the outlet backbox to the equipment cabinet or backboard serving that location. Other requirements are detailed on the Drawings.

Provide an insulated throat EMT connector on the end of the conduit to protect the wire(s) from abrasion where cables enter or exit the open end of a conduit. Where conduit terminates at a backboard, secure conduit at the top of the backboard by means of appropriate conduit clamps.

Coordinate with other electrical work, including raceways, electrical boxes and fittings, as necessary to interface installation of telephone/data raceways with other work.

Install pull wire in each telephone/data raceway. Label each conduit as specified in Section 260533, *ELECTRICAL IDENTIFICATION*, to indicate room number of termination of the conduit run.

END OF SECTION 270528

SECTION 283110 - FIRE ALARM SYSTEM MODIFICATIONS

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

SCOPE

This section of the specifications includes the furnishing, installation, and connection of new initiation devices, alarm appliances, and related items to an existing fire alarm system. The final product shall be a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, auxiliary control devices, annunciators, power supplies, and wiring as shown on the Drawings and specified herein.

QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacture of fire alarm systems of types, sizes, and electrical characteristics required, and whose products are Listed and Labeled. Products of firms that do not maintain factory authorized service organization and spare parts stock are not acceptable for use on this project.

Installer's Qualifications: Installer shall be a company specializing in performing the work of this section, with a minimum of 5 years documented experience installing fire detection and alarm systems similar in size and scope to this project. Installer shall be certified by the manufacturer to install, program and service the system. Installer shall directly provide the final connections between the equipment and the wiring system and the addressing of all system devices.

Installer shall directly provide the installation of all wiring and devices required in the system, or provide supervision over this work when provided by the electrical contractor. Installer shall not sub-contract any portion of the required work to a third party. All work shall be performed in accordance with the Installer's submitted and approve fire alarm shop drawings and calculations.

System programming shall be done only by a manufacturer, or by an authorized Installer. The Installer's technicians who perform this work shall be trained and individually certified by the manufacturer, for the model and series of equipment being installed. The technicians' training and certification must have occurred in the most recent 24 months. Qualifications of installer, including technician certifications, shall be provided with equipment submittal.

Installer shall be present on site for the 100% test, Designer's pre-final review and Owner inspections.

Codes and Standards:

NFPA Compliance: Comply with applicable requirements of NFPA-72, 2013 National Fire Alarm Code.

NEC Compliance: Comply with applicable requirements of NFPA-70, National Electrical Code (NEC) standards pertaining to fire alarm systems.

Testing Laboratory Compliance: Comply with provisions of UL safety standards pertaining to fire alarm systems. Provide products and components which are Listed and Labeled.

UL Compliance: Provide fire alarm notification appliances consistent with requirements in UL 1971, Signaling Devices for the Hearing Impaired, for determining device operating currents and device ratings.

NCBC Compliance: Fire Alarm notification appliances shall comply with NC Building Code and NC Accessibility Code criteria for intensity and placement.

FM Compliance: Provide fire alarm systems and accessories which are FM approved.

SUBMITTALS

Submittals shall be made in strict accordance with the requirements of Section 019913. Specific submittal requirements are defined in each section of this Division.

Product Data: Submit Manufacturer's technical product data, including specifications and installation instructions, for each type of fire alarm system equipment. Submit technical product data on the fire alarm service equipment. Submittals shall provide mA draw for each device submitted and UL listed minimum voltage required to operate. Panel submittal shall list voltage drop allowed for panel and for individual NAC circuits.

Shop Drawings: Submit shop drawings showing equipment, device identification numbers and locations, and connecting wiring of entire fire alarm system. Include wiring and riser diagrams. Wiring diagrams shall be based on the project floor plans, with devices and proposed conduit routing shown. Provide conductor composition for each conduit section. Provide distance and route for each NAC (Notification Appliance Circuit). Risers diagrams shall show consecutive connections for all devices with addresses and ratings. Copies of Project Construction Documents or details therefrom may not be a part of the shop drawing submittal. Shop drawings shall be prepared in an electronic format that is convertible to DXF files. The fire alarm contractor shall submit complete shop drawings to the engineer for review prior to installation.

Wiring and Cabling: Submit wire and cable for signal circuits and notification circuits.

Installation Instructions: Submit Manufacturer's detailed installation instruction for all duct mounted smoke detectors, flow switches, tamper switches, supervisory switches, and similar items which require mechanical installation.

Battery Calculations: Provide battery calculations used to size secondary power source. Calculations must be submitted prior to installation of equipment. Battery calculations shall utilize the UL 1971 RMS DC or full wave rectified (FWR) current values of notification appliances, as appropriate for the power supply used, provided by the product manufacturer. These values shall be highlighted in the submittal for each appliance used in the project. Identify notification appliance circuit (NAC) current draws and calculate voltage drops for each circuit in the submittal package. Identify EOL voltage for each proposed NAC, based on a source voltage of 20.4 volts. In no case shall the calculated EOL for any NAC be below the minimum listed operating voltage for the devices used.

Device List: Submit a listing for each addressable device that indicates the device address, function and location. This information shall be the basis for the device descriptions to be programmed into the system, contingent upon approval of Designer and Owner. Information shall be included in device identification that is observed at the FACP and FAAP. Device addresses shall exactly match the information provided on the shop drawings.

Maintenance Data: Submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual.

1. Semiannual systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, water flow switches and all accessories of the fire alarm system.
2. Semiannual testing of each circuit in the fire alarm system.
3. Semiannual testing of each smoke detector in accordance with the requirements of NFPA 72, Chapter 7.

Certifications: Submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses, and telephone numbers in the certification.

PART 2 - PRODUCTS

ANCILLARY EQUIPMENT

ALARM APPLIANCES

Programmable Electronic Sounders shall be located as shown on the Drawings; sounders located outdoors shall be listed for use in wet locations. Electric sounders shall operate with synchronized audible output and have the following specifications:

Voltage: Programmable electronic sounders shall operate on 24 VDC nominal.

Programming: Electronic Sounders shall provide the ANSI S3.41 three-pulse temporal pattern audible evacuation signal, described in NFPA 72, with an output sound level of at least 90 dBA measured at 10 feet from the device. Output sound level shall be 120 dB maximum. Electronic Sounders shall be field programmable without the use of special tools.

Mounting: Provide flush mounting devices suitable for mounting in a standard single gang device box unless otherwise indicated on the Drawings. Unless otherwise indicated on the Drawings, electronic sounders shall be mounted at 6'-8" (2.05 M) Above Finished Floor (AFF) or 6" (15.3 Cm) Below Finished Ceiling (BFC), whichever is lower.

Strobe Lights shall be located as shown on the Drawings. Strobe lights indicated for use exterior to the building shall be mounted at the indicated elevation and listed for use in wet locations. Strobe lights shall operate with synchronized flash output and have the following specifications:

Voltage: Strobe lights shall operate on 24 VDC nominal.

Maximum pulse duration: 2/10ths of one second.

Mounting: Provide flush mounting devices suitable for mounting in a standard single gang device box unless otherwise indicated on the Drawings. Unless otherwise indicated on the Drawings, strobe lights shall be mounted with the lower edge of the visual element at 6'-8" (2.05 M) Above Finished Floor (AFF) or 6" (15.3 Cm) Below Finished Ceiling (BFC), whichever is lower.

Strobe intensity and flash rate: Must meet minimum requirements of UL 1971. Provide strobe lights with minimum intensity Candela (Cd) rating of 15 Cd, or greater if such is indicated adjacent to the device symbol on the Drawings.

Audible/Visual Combination Devices shall be located as shown on the Drawings and shall comply with all applicable requirements for both Audible Device and Strobe Lights. Unless otherwise indicated on the Drawings, combination A/V devices shall be mounted with the lower edge of the visual element at 6'-8" (2.05 M) Above Finished Floor (AFF) or 6" (15.3 Cm) Below Finished Ceiling (BFC), whichever is lower.

Bells shall be 10" diameter vibrating type located as shown on the Drawings; bells located outdoors shall be listed for use in wet locations. Bells shall have the following specifications:

Voltage: Bells shall operate on 24 VDC nominal.

Mounting: Provide flush mounting devices suitable for mounting in a standard single gang device box unless otherwise indicated on the Drawings. Bell mounting elevation shall be as described on the Drawings.

INITIATING DEVICES

MISCELLANEOUS SYSTEM ITEMS

Batteries: Shall be completely maintenance free, shall not require liquids, fluid level checks or refilling, and shall not be capable of producing spills and/or leaks. Batteries shall be sealed gel-cell type with expected life of 10 years. Battery voltage shall be as required by the power supply ad related equipment. Battery shall have sufficient capacity to power the fire alarm system for not less than 24 hours plus 5 minutes of alarm upon a normal AC power failure. The connected load for NAC circuits shall not exceed 75% of rated current output of the power supply.

PART 3 - EXECUTION

Fire and smoke detection and alarm systems shall comply with the following system requirements with regard to operation and installation.

All equipment and components shall be installed in strict compliance with manufacturers' recommendations. All equipment supplied must be specifically listed for its intended use and shall be installed in accordance with any instructions including in its listing. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all specific system installation/termination/wiring data.

All system components shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (*e.g.*, detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load. Adhesives are not permitted to mount fire alarm system components to building surfaces or structure.

The system shall be new and furnished with a warranty (parts & labor) of at least one year from the date of final inspection and acceptance by the Owner. Equipment, initiating devices, and alarm appliances shall be arranged as described in the Drawings; annunciator zones shall be configured as described in the Drawings.

Both audible and visible alarm signals shall be provided. Visible signals must be the strobe (flash discharge) type, with white or clear lens, and shall comply with current ADA requirements for intensity and placement.

Systems are to be provided with a separate and independent source of emergency power. Switching to emergency power during alarm shall not cause signal drop-out. Batteries must meet the appropriate NFPA capacity requirements, with a 25% safety factor. This requirement is in effect even if generator power is supplied to the Fire Alarm Control Panel.

Style 6 Circuits Required: Systems with one or more addressable sub-panels that (1) have an integral addressable loop controller, or (2) monitor multiple non-addressable initiation zones, shall comply with the NFPA 72 requirements for Style 6 circuits.

All wiring shall be color coded in accordance with the following scheme, which shall be maintained throughout the system, without color change in any wire run:

Signal Line Circuit cable	Red jacket with Red(+)/Black(-)
Alarm Indicating Appliance Circuits	Blue (+)/Black (-)
AHU Shutdown Circuits	Yellow (+)/Brown (-)
Initiation Circuits from Monitor Modules	Violet (+)/Gray (-)
Door Control Circuits	Orange
Elevator Capture Circuits	Brown

There shall be NO splices in the system other than at terminals in panels, fire alarm terminal cabinets (FATC) and devices. "Wire nuts," crimp splices, or insulation piercing type connectors are not acceptable. All terminal blocks shall be mounted in enclosures. All terminal screws shall have pressure wire connectors of the self-lifting or box lug type.

Permanent wire markers shall be used to identify all splices and terminations for each circuit. For splices within FATC's, use markers or other means to indicate which conductors leads to the FACP.

In multistory buildings, all circuits leaving the riser on each floor shall feed through a labeled terminal block in an FATC with hinged cover, located for convenient access as indicated on the drawings. All required splices shall be made on termination blocks that are securely mounted in the cabinet. Wire markers and corresponding wiring legend shall be arranged as indicated on FATC detail on Drawings.

All fire alarm system cables and conductors shall be installed in raceway, couplers, and connectors meeting the performance of installation requirements of Section 260534, RACEWAYS. The minimum size for fire alarm system raceway shall be 3/4" trade size.

The exterior of all junction boxes containing fire alarm conductors shall be painted red; box interiors shall not be painted. Box covers for junction boxes containing fire alarm conductors shall be painted red on both sides. All painting of junction boxes and junction box covers shall be accomplished prior to installation of the boxes to avoid possible problems with overspray. Those boxes in finished areas are permitted to be painted to match the finish color.

Box covers shall be labeled to indicate the circuit(s) or function of the conductors contained therein. Labels shall be neatly applied black lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.

Raceways that penetrate outside walls from conditioned space shall have an internal seal to prevent condensation within the raceway as it enters the conditioned space.

Provide metal backboxes or plastic skirts as manufactured by the fire alarm manufacturer for devices installed in a surface mounted application. Such boxes shall match device in size and color.

Wire shall be new AWG #14 minimum stranded copper, type THHN/THWN for Notification Appliance Circuits. Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACP. Acceptable cables include Atlas 22-18-1-1STP, BSCC S1802s19 (same as EEC 7806LC), West Penn D975, D991 (AWG 16), D995 (AWG 14), or equal wire having capacitance of 30pf/ft maximum between conductors. The cable jacket color shall be red, with red (+) and black (-) conductor insulation.

EXCEPTION #1: Unshielded cable, otherwise equal to the above, is permitted to be used where the manufacturer's installation instructions unequivocally require, or state a preference for, the use of unshielded cable for all systems, AWG #16 minimum.

EXCEPTION #2: In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.

Detection or alarm circuits must not be included in raceways containing AC power or AC control wiring. Within the FACP, any 120 VAC control wiring or other circuits with an externally supplied AC/DC voltage above the nominal 24 VDC system power must be properly separated from other circuits and the enclosure must have an appropriate warning label to alert service personnel to the potential hazard.

Branch circuit breakers serving fire alarm systems shall be physically protected from inadvertent contact using a breaker handle lock. Load designation shall be clearly identified (typed) in the panel directory. Breakers shall be further identified with a permanent red dot applied to the handle or other visible portion of the breaker. Do not cover operable portions of the breaker or written information on the case in meeting this requirement.

All wiring shall be checked for grounds, opens, and shorts, prior to termination at panels and installation of detector heads. The minimum resistance to ground or between any two conductors shall be ten megohms (10 MW), as verified with a megger. Provide advance notice to the A-E of these tests.

All connections at the FACP must be made by the Manufacturer's authorized, factory trained representative (rather than by the electrical contractor).

The system shall be electrically supervised for open or (+/-) ground fault conditions in SLC, alarm circuits, and control circuits. Removal of any detection device, alarm appliance, plug-in relay, system module, or standby battery connection shall also result in a trouble signal. Fire alarm signal shall override trouble signals, but any pre-alarm trouble signal shall reappear when the panel is reset.

FIRE ALARM SYSTEM INSTALLATION AND CONFIGURATION

In addition to other requirements of these Specifications the fire alarm system must comply with the following:

The addressable fire alarm system shall be connected, programmed, and tested only by the Manufacturer or by an authorized distributor who stocks a full compliment of spare parts for the system. Technicians performing this service shall be trained and individually certified by the Manufacturer for the model of system being installed. Copies of installer certification must be included with the Contractor's submittal.

The complete configuration data (site-specific programming) for the system must be permanently stored on a USB drive or compact disc (CD) and archived by the manufacturer or authorized distributor. A USB drive or compact disc (CD) copy of this data must be submitted to the A-E for transmission to the Owner when the system is commissioned.

The Manufacturer or authorized distributor must maintain software version (VER) records on the system installed. The system software shall be upgraded free of charge if a new VER is released for any reason during the warranty period. For any new VER to correct problems, free upgrade shall apply during the entire life of the system.

All addressable loop controller circuits (SLCs) must be NFPA 72 Style 6 ("Class A") and shall have a minimum of 20% spare addresses for future use. "T-taps" from the loop are not permitted. To minimize the impact of a wiring fault on the system, isolation modules must be provided as follows:

1. At the FACP, at each end of the loop.
2. At the mid-point of a loop with less than 20 devices or control points.
3. After each 20 devices/control points on any addressable circuit.
4. For each circuit extending outside the building.
5. At each terminal cabinet on loops serving multiple floors (each floor).

Notification Appliance Circuits (NACs) shall be NFPA 72 Style Y (Class B). The load connected to each circuit must not exceed 80% of rated supply output. The coverage of each circuit shall not exceed 3 floors. The NAC voltage drop during alarm shall not exceed 14% of the voltage measured across the batteries. The contractor shall use power outage testing to verify proper installation.

Supervision required: The connection between individual addressable modules and their contact type initiating device(s) must be supervised.

The Fire Alarm System shall have multiple access levels which permit the Owner's authorized personnel to disable individual alarm inputs or normal system responses (outputs) for alarms without changing the system’s executive programming or affecting operation of the rest of the system. This must include the ability to override selected alarm inputs or system responses to alarms without affecting the remaining portions of the system. The owner shall be taught how to make these changes in the training program provided.

Floor Plans with Device Numbers: A copy of the floor plans shall be provided in the control panel. A separate sheet shall be provided for each floor. Plans shall be reduced in size from engineering plans in order to fit on 11 x 14 sheets. All device addresses shall be clearly labeled on plans. Indicate locations of all cabinets, modules and end of line resistors. Plans shall be bound in book form. Sheets shall be laminated. Provide legend for symbols. Provide holder for plan book in panel or in a locked box adjacent to panel keyed to match panel. Provide label for box and book.

In addition to the system tests and certification described elsewhere, the Manufacturer or authorized distributor must 100% test all site-specific software functions for the system and provide a written test report or detailed check list.

SYSTEM DOCUMENTATION

The contractor shall provide the A-E with three copies of the following:

1. As-built wiring and conduit layout diagrams, including wire color code and/or label numbers, and showing all interconnections in the system.
2. Electronic circuit diagrams of all control panels, modules, annunciators, communications panels, etc.
3. Technical literature on all major parts of the system, including control panels, batteries, detectors, manual stations, alarm indicating appliances, power supplies, and remote alarm transmission means.
4. Detailed maintenance requirements as recommended by the fire alarm manufacturer.

The contractor shall provide the A-E with one copy of the following:

1. All software required, both for the installed fire alarm system and for any personal computer (PC) necessary to access the fire alarm system for trouble shooting, programming, modifications, monitoring, de-bugging, or similar functions.
2. Complete documentation for all software for both the installed fire alarm system and for any interface PC software necessary for system functions as described in (1) above.
3. Framed floor plans for installation at the FACP. Plans shall show all system devices with the unique device identification numbers indicated adjacent to each device. The identification numbers shall match those represented in the as-built drawings and those reported at the FACP and the LCD annunciator.

SYSTEM TESTING & CERTIFICATION

Upon completion of the installation the Division 28 Contractor and the Manufacturer's authorized installer together shall conduct a 100% performance test of each and every new device for proper response. The system shall operate for 48 hours prior to start of test. The Division 28 Contractor shall be present for the full 100% test.

The Contractor's 100% Performance test shall consist of the following. Upon activation of each alarm initiating device, verify effective operation of every new alarm notification appliance and all other functions. In addition, verify proper annunciation of each activated device, including device identification number, type and location, at the FACP and each remote annunciator. The FACP shall reset after testing of each alarm initiating device. The digital communicator shall be on-line and tested for proper communication to the receiving station. Equivalent methods of demonstrating proper operation of HVAC shutdown are acceptable for this test. All supervised circuits must also be tested to verify proper supervision. (Control circuits and remote annunciation lines are among those required to be supervised.) Provide a 10% test of the existing building fire alarm system devices and functions to confirm originally designed operation.

All testing described above shall be repeated in the event that subsequent software or wiring modifications are determined necessary to meet the requirements of the contract documents. Such re-testing shall be included as part of the base bid and provided at no additional cost to the Owner.

The A-E must be given 7 days advance notice of the tests.

The contractor must submit the following test documentation:

1. Written verification that this 100% system test was done with copy of print out generated during test.
2. System status and programming report, including a system operation matrix showing the actual FACP response for each initiating device. In addition, provide the measured sensitivity of each smoke detector. (Generate on date of Designer Pre-Final).
3. NFPA 72-2013 "Record of Completion" form: Use this form to detail the system installation and to certify that it was installed per code requirements.
4. Voltage table indicating voltage at battery and at the last device on each NAC circuit. Take readings at the start of test and every 15 minutes during NAC test. Test shall be 30 minutes minimum.

After completion of the Contractor's 100% performance test and submission of the above documentation, the contractor will request in writing that the A-E set up a pre-final review.

If the initial inspection determines that the required 100% system test was not reasonably done, or if a reinspection of the project is requested without the punch list being nearly completed, the Contractor *may* be required to reimburse the Designer for inspection costs.

System Report: In addition to the shop drawing submittal the fire alarm system contractor shall provide the engineer two bound copies of the following technical information, for transmittal to the owner:

1) As-Built wiring diagram showing all loop numbers and device addresses, plus terminal numbers where they connect to control equipment.
2) Manufacturer's detailed maintenance requirements
3) Technical literature on all control equipment, isolation modules, power supplies, alarm/ supervisory signal initiating devices, alarm notification appliances, relays, etc…
4) The as-built "calculations" sheet referenced elsewhere in this specification.

Electronic archive: Complete configuration data (site-specific programming) for the system must be stored on electronic media and archived by the fire alarm system manufacturer or authorized distributor. A USB drive or compact disc (CD) copy of this data shall be submitted to the engineer for transmission to the owner.

INSPECTIONS

Fire Alarm System Designer Pre-final Review: Upon completing the fire alarm system installation, and prior to scheduling the Designer Pre-final review, the installation contractor must successfully conduct and complete a 100% performance test of the entire fully functional system. All audio visual device tests shall be scheduled with the owner.

As part of the Designer Pre-final review the system will be inspected and functionally tested on a comprehensive basis. Equipment intended for open area protection or releasing device service may be subjected to simulated or actual test fires in accordance with ANSI/UL guideline and sound engineering practice, to verify proper response.

The Contractor shall provide two-way radios, equipment keys, as-built drawings, ladders, smoke products, meter and other materials required to test the system. The test will be conducted entirely by the Contractor. Any deficiencies shall be recorded and corrected. After the items have been corrected, the system shall be tested again in the presence of the Engineer.

In the event of malfunctions or excessive nuisance alarms, the Contractor must take prompt corrective action. The Owner may require a repeat of the Contractor's 100% system test, or other inspections. Continued improper performance during the warranty period shall be cause to require the Contractor to remove and replace the system.

Test Report: Upon successful completion of the Performance Inspection and correction of all deficiencies, the manufacturer's authorized representative shall issue a test report to the Engineer, detailing and certifying the test.

Final Inspection: At the Owner's request and after passing the pre-final review, the Division 28 Contractor and Manufacturer's authorized installer will conduct a full system test in the presence of the Owner and the Designer. Upon request, a copy of the final database software must be presented to the Owner on USB drive before this test. The software shall be loaded from the drive into the system in the presence of the Owner and Engineer. See requirements for pre-final test and conduct similarly.

System Acceptance: After successful completion of the Final Inspection and recommendation of the Engineer, the system will be accepted by the Owner. At this time the warranty period begins. In the event of malfunctions or excessive nuisance alarms, the Contractor must take prompt corrective action. The Owner may require a repeat of the Contractor's 100% system test, or other inspections. Continued improper performance during the warranty period shall be cause to require the Contractor to remove the system.

END OF SECTION 283110